MACHINERY.

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HEATERS FOR HOT BLAST AND VENTILATION.

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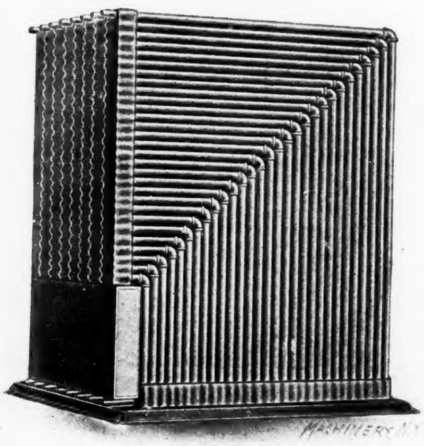


Fig. 1. Sturtevant Miter Type Heater.

THE best type of heater for any particular case will depend upon the volume and final temperature of the air, the steam pressure and the available space. When the air is to be heated to a high temperature for both warming and ventilating a building as in the case of a shop or mill, or for drying purposes, heaters of the general form shown in Figs. 1, 3 and 4 are used. These may also be adapted to all classes of work by varying the proportions as required. They can be made shallow and of large superficial area for the comparatively low temperatures used in purely ventilating work, or deeper, with less height and breadth as higher temperatures are required.

Description of Types of Heaters.

Fig. 3 shows the general construction of the standard hot blast heater of the B. F. Sturtevant Company. This consists of several sectional cast iron bases with loops of wrought iron pipe connected as shown. The steam enters the upper part of the bases or headers and passes up one side of the loops, then across the top and down on the other side, where the condensation is taken off through the return drip, which is separated from the inlet by a partition. These heaters are made up in sections of 2 and 4 rows of pipes each, and can

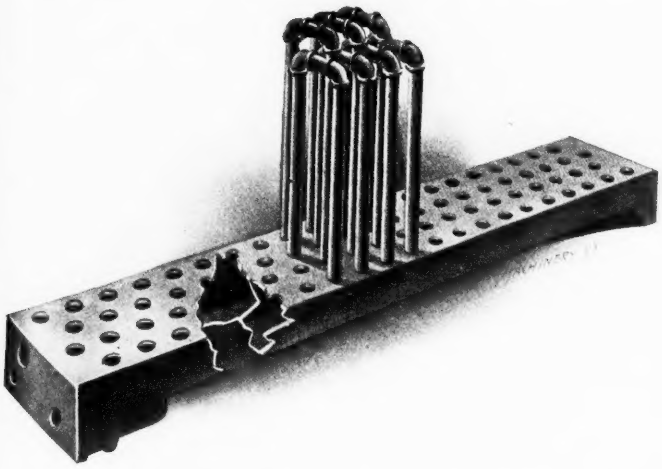


Fig. 2. American Blower Co.'s Hot Blast Heater, Four-pipe Section.

be made any depth desired by adding more sections. The height varies from 3½ to 9 feet and the width from 3 feet to 7 feet in the standard sizes. They are usually made up of one-inch pipe, although 1¼ inch is commonly used in the larger sizes.

For convenience in estimating the approximate dimensions of a heater, Table I, page 354, is given. The standard heaters made by different manufacturers vary somewhat, but the dimensions given in the table represent average practice. Column 3 gives the square feet of heating surface in a single row of pipes of the dimensions given in columns 1 and 2, and column 4 gives the free area between the pipes.

In calculating the total height of the heater add 1 foot for the base. These sections are made up of 1-inch pipe except the last, or 7-foot sections, which are made of 1¼-inch pipe.

Fig. 1 shows the miter type of the Sturtevant heater, with single-chambered inlet and outlet sections. This arrangement provides absolute freedom of expansion and perfect circulation. Steam is admitted at the top of the inlet section, and the drips removed from the end of the outlet section. Heaters of this type are usually enclosed in a steel casing as shown in Fig. 14, although brick walls are often used for heaters of large size.

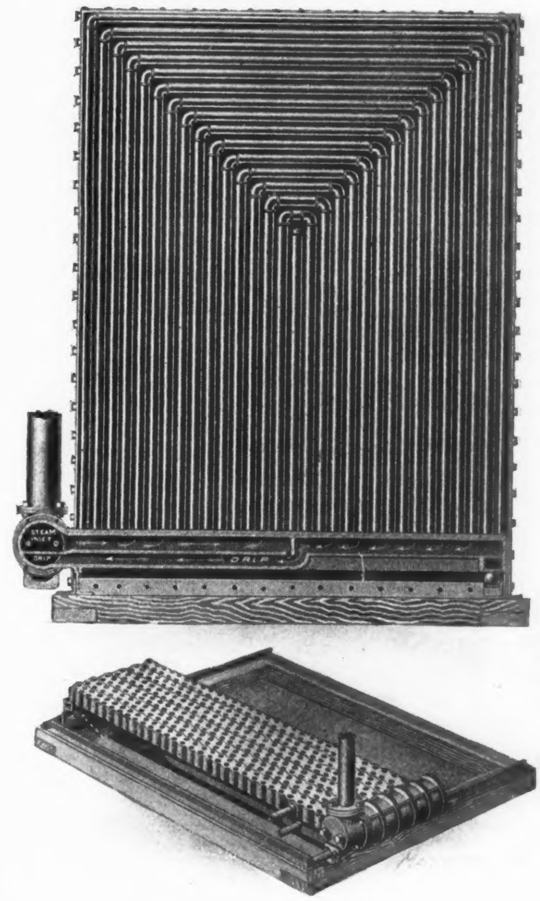


Fig. 3. Sturtevant Hot Blast Heater.

Fig. 2 illustrates the construction of a 4-pipe section of the heater made by the American Blower Company, and Fig. 4 the same heater complete, without its steel plate casing. This heater is similar in appearance to the one just described, but differs somewhat in its construction. The base is divided lengthwise by an inside partition, so that the two pipes or legs of each loop connect with different chambers, one of which connects with the steam supply and the other with the return.

Fig. 5 shows a special form of heater particularly adapted to ventilating work where the air does not have to be raised above 75 or 80 degrees. It is made up of 1-inch wrought iron pipe connected with supply and return headers; each section contains 14 pipes, that is, 2 pipes wide and 7 pipes deep, and they are usually made up in groups of 5 sections each. These coils are supported upon T-irons resting upon a brick foundation. Heaters of this form are usually made to

extend across the side of a room with brick walls at the sides instead of being encased in steel housings.

Figs. 6, 7 and 9 show the "Vento" cast iron hot blast heater made by the American Radiator Company. This type of heater is to be used under the same conditions as the pipe heaters already described. Fig. 6 shows a group of sections and illustrates the general construction and method of connection. Fig. 7 shows the sections arranged in a stack, five rows deep; and Fig. 9 the same stack with its steel casing and the supply and return connections.

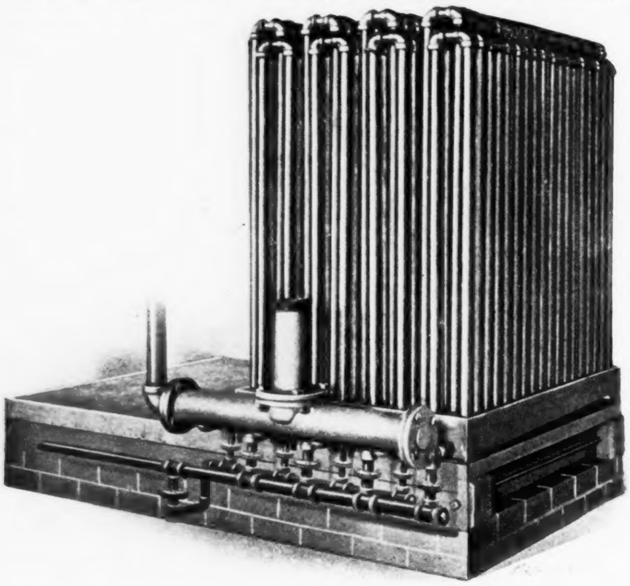


Fig. 4. American Blower Company's Heater Complete without Casing.

Cast iron indirect radiators of the pin pattern shown in Fig. 8 are well adapted for use in connection with mechanical ventilation, and also for heating where the air volume is large and the temperature not too high, as in churches and halls. They make a convenient form of heater for schoolhouse and similar work, for being shallow, they can be supported upon I-beams at such an elevation that the condensation may be returned to the boilers by gravity.

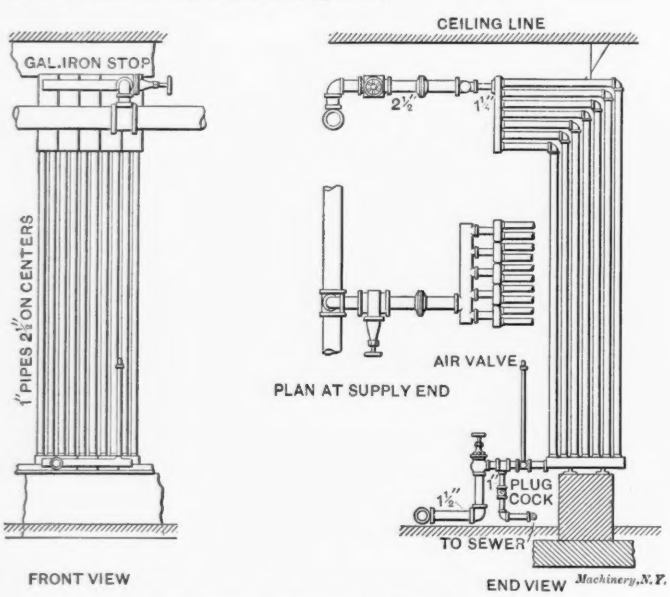


Fig 5. Special Heater used in Ventilating Work.

In the case of vertical pipe heaters the bases are below the water-line of the boilers, and the condensation must be returned by the use of traps and pumps.

Efficiency of Pipe Heaters and Calculations of Sizes Required.

The efficiency of the heaters used in connection with forced blast varies greatly, depending upon the temperature of the entering air, its velocity between the pipes, the temperature to which it is raised, and the steam pressure carried in the heater. The general method in which the heater is made up is also an important factor.

In designing a heater of this kind, care must be taken that the free area between the pipes is not contracted to such an extent that an excessive velocity will be required to pass the given quantity of air through it. In ordinary work it is customary to assume a velocity of 800 to 1,000 feet per minute; higher velocities call for a greater pressure on the fan which is not desirable in ventilating work.

TABLE I.

Width of Section Feet.	Height of Pipes Ft.	In.	Surface Sq. Feet.	Free Area through Heater. Sq. Feet.
3	3	6	20	4.2
3	4	0	22	4.8
3	4	6	25	5.4
3	5	0	28	6.0
4	4	6	34	7.2
4	5	0	38	8.0
4	5	6	42	8.8
4	6	0	45	9.6
5	5	6	52	11.0
5	6	0	57	12.0
5	6	6	62	13.0
5	7	0	67	14.0
6	6	6	75	15.6
6	7	0	81	16.8
6	7	6	87	18.0
6	8	0	92	19.2
7	7	6	98	21.0
7	8	0	103	22.4
7	8	6	109	23.8
7	9	0	116	25.2

In the heaters shown, about 0.4 of the total area is free for the passage of air; that is, a heater 5 feet wide and 6 feet high would have a total area of $5 \times 6 = 30$ square feet, and a free area between the pipes of $30 \times 0.4 = 12$ square feet. The depth or number of rows of pipe does not affect the free area, although the friction is increased and additional work is thrown upon the fan. The efficiency in any given heater will be increased by increasing the velocity of the air through it, but the final temperature will be diminished, that is, a larger quantity of air will be heated to a lower temperature in the second case, and while the total heat given off is greater, the air quantity increases more rapidly than the heat quantity, which causes a drop in temperature.

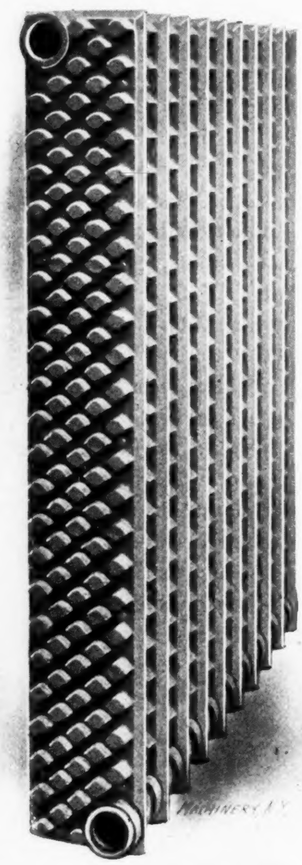


Fig. 6. "Vento" Cast Iron Heater.

Increasing the number of rows of pipe in a heater with a constant air quantity, increases the final temperature of the air but diminishes the efficiency of the heater, because the average difference in temperature between air and steam is less. Increasing the steam pressure in the heater (and consequently its temperature) increases both the final temperature of the air and the efficiency of the heater. Table II has been prepared from different tests and may be used as a guide in computing probable results under ordinary working conditions. In this table it is assumed that the air enters the heater at a temperature of zero and passes between the pipes with a velocity of 800 feet per minute. Column 1 gives the number of rows of pipe in the heater and columns 2, 3 and 4 the final temperature of the air for different steam pressures. Columns 5, 6 and 7 give approximately the corresponding efficiency of the heater.

Example:—Air passing through a heater 10 pipes deep and carrying 20 pounds pressure will be raised to a temperature of 90 degrees and the heater will have an efficiency of 1,650 B. T. U. per square foot of surface per hour.

For a velocity of 1,000 feet, multiply the *temperatures* given in the table by 0.9 and the *efficiencies* by 1.1.

Example:—How many square feet of radiation will be required to raise 600,000 cubic feet of air per hour from zero to 80 degrees, with a velocity through the heater of 800 feet per minute and a steam pressure of 5 pounds? What must be the total area of the heater front and how many rows of pipes must it have?

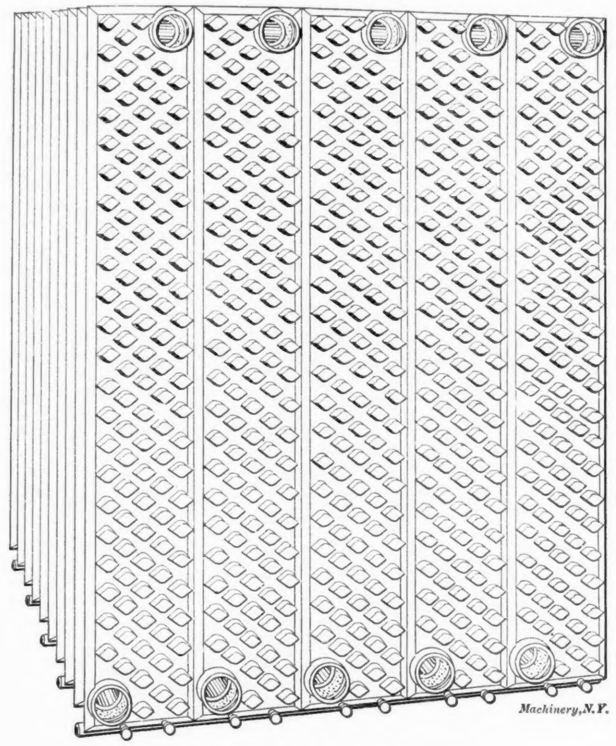


Fig. 7. "Vento" Cast Iron Heater.

The B. T. U. required is found by multiplying the volume of air by the desired rise in temperature and dividing the result by 55, hence $600{,}000 \times 80 \div 55 = 872{,}727$ B. T. U. required.

Referring to Table II we find that for the above conditions a heater 10 pipes deep is required, and that an efficiency of 1,500 B. T. U. will be obtained. Then $872{,}727 \div 1{,}500 = 582$

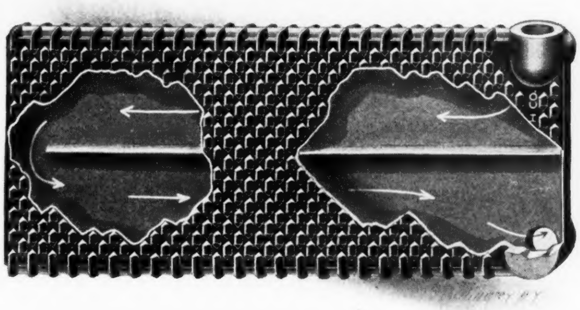


Fig. 8. Pin Type Heater.

square feet of surface required, which may be taken as 600 in round numbers. $600{,}000 \div 60 = 10{,}000$ cubic feet of air per minute, and $10{,}000 \div 800 = 12.5$ square feet of free area required through the heater. If we assume 0.4 of the total heater front to be free for the passage of air, then $12.5 \div 0.4 = 31.25$ square feet, total area required.

The general method of computing the size of heater for any given building which is to be both ventilated and warmed by a hot-blast system, is the same as in the case of indirect heating. First obtain the B. T. U. required for ventilation, and to that add the heat loss through walls, etc., and divide the result by the efficiency of the heater under the given conditions.

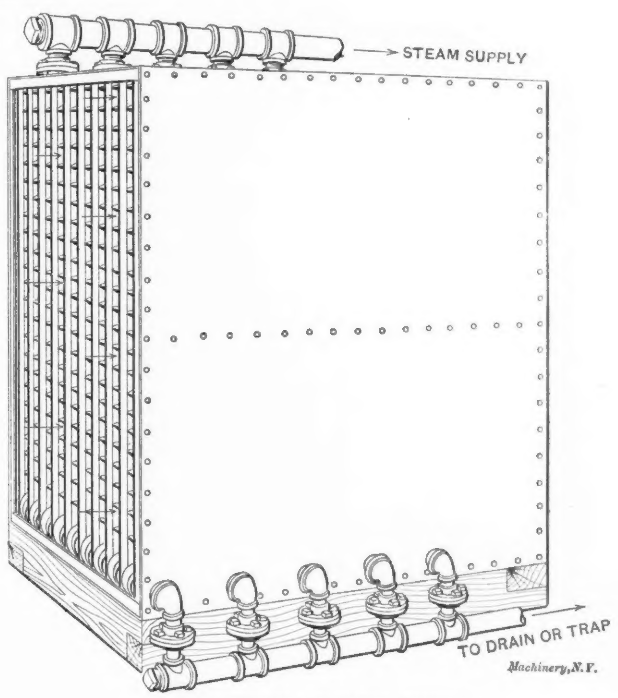


Fig. 9. "Vento" Cast Iron Heater.

Example:—An audience hall is to be provided with 400,000 cubic feet of air per hour. The heat loss through walls, etc., is 250,000 B. T. U. per hour in zero weather. What will be the size of heater, and how many rows of pipe deep must it be, with 20 pounds steam pressure?

$400{,}000 \times 70 \div 55 = 509{,}090$ B. T. U. for ventilation. Therefore $250{,}000 + 509{,}090 = 759{,}090$ B. T. U., total to be supplied.

TABLE II.

Temperature of entering air, zero.
Velocity of air between the pipes, 800 feet per minute.

Rows of Pipe Deep.	Temp. to which the Air will be raised from zero. Steam Pressure in Heater.			Efficiency of the Heating Surface in B T. U. per sq. ft. per hour. Steam Pressure in Heater.		
	5 lbs.	20 lbs.	60 lbs.	5 lbs.	20 lbs.	60 lbs.
4	30	35	45	1600	1800	2000
6	50	55	65	1600	1800	2000
8	65	70	85	1500	1650	1850
10	80	90	105	1500	1650	1850
12	95	105	125	1500	1650	1850
14	105	120	140	1400	1500	1700
16	120	130	150	1400	1500	1700
18	130	140	160	1300	1400	1600
20	140	150	170	1300	1400	1600

We must next find to what temperature the entering air must be raised in order to bring in the required amount of heat, so that the number of rows of pipe in the heater may be obtained and its corresponding efficiency determined. We have entering the room for purposes of ventilation, 400,000 cubic feet of air every hour at a temperature of 70 degrees,

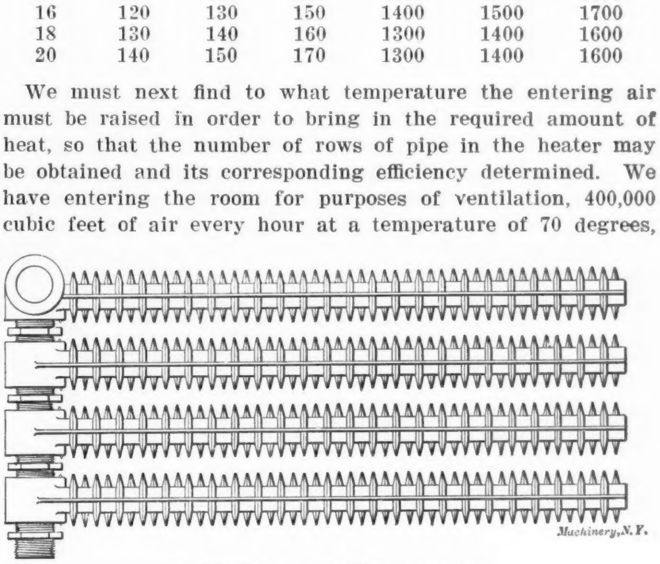


Fig. 10. Diagram of Pin Type Heater.

and the problem now becomes, to what temperature must this air be raised to carry in 250,000 B. T. U. additional for warming?

We know that 1 B. T. U. will raise 55 cubic feet of air 1 degree. Then 250,000 B. T. U. will raise $250{,}000 \times 55$ cubic

feet of air 1 degree. Thus $250{,}000 \times 55 \div 400{,}000 = 34$ degrees, required excess temperature. The air in this case must then be raised to $70 + 34 = 104$ degrees to provide for both ventilation and warming. Referring to Table II we find that a heater 12 pipes deep will be required, and that the corresponding efficiency of the heater will be 1,650 B. T. U. Then $759{,}090 \div 1{,}650 = 460$ square feet of surface required.

Heating Surface Required for Factories.

The proportional heating surface for factory heating is generally expressed in the number of cubic feet in the building for each linear foot of 1-inch steam pipe in the heater. On this basis, in factory practice, with all of the air taken from out of doors, there are generally allowed from 100 to 150 cubic feet of space per foot of pipe according as exhaust or live steam is used, live steam in this case indicating steam of about 80 pounds pressure. If practically all of the air is returned from the buildings to the heater, these figures may be raised to about 140 as a minimum, and possibly 200 as a maximum, per foot of pipe.

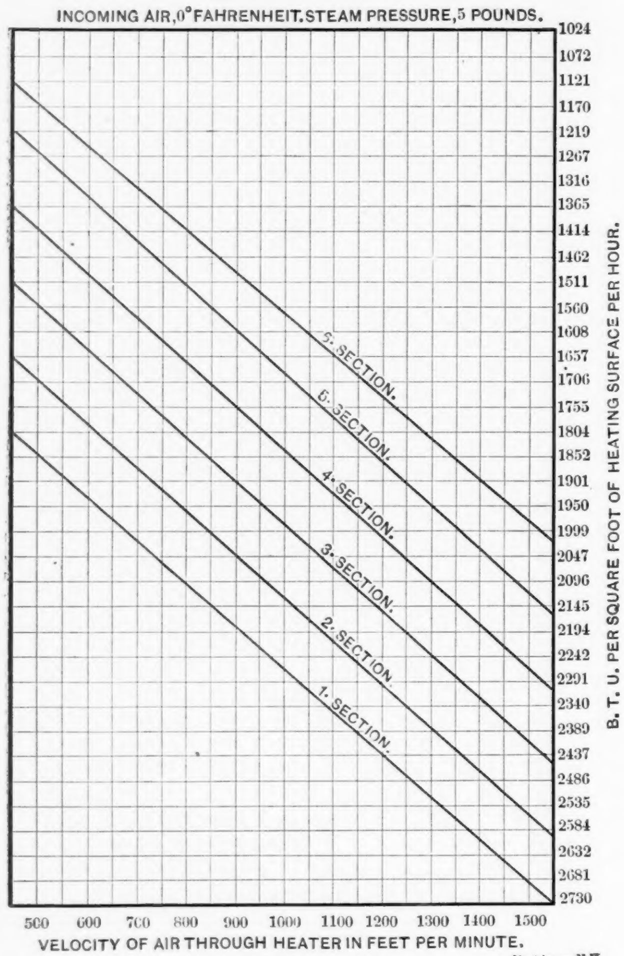


Fig. 11. Condensation Chart.

Temperature and Condensation Charts.

The accompanying "temperature" and "condensation" charts show the results obtained with the "Vento" cast iron heater and the data given therein correspond to that found in Table II for pipe heaters. These charts explain themselves and require no further description.

Indirect Pin Radiators.

Heaters made up of indirect pin radiators of the usual depth have an efficiency of at least 1,500 B. T. U. with steam at 5 pounds pressure, and are easily capable of warming air from zero to 80 degrees or over when computed on this basis. The free space between the sections bears such a relation to the heating surface that ample area is provided for the flow of air through the heater without producing an excessive velocity.

Pipe Connections.

Hot blast heaters, commonly called main heaters, are usually divided into several sections, the number depending upon their size, and each provided with a separate valve in the supply and return. In making these divisions, special care should be taken to arrange for as many combinations as possible.

Example:—A heater, 10 pipes deep, may be made up of three sections, one of 2 rows and two of 4 rows each. By means of this division, 2, 4, 6, 8 or 10 rows of pipe can be used at one time, as the outside weather conditions may require.

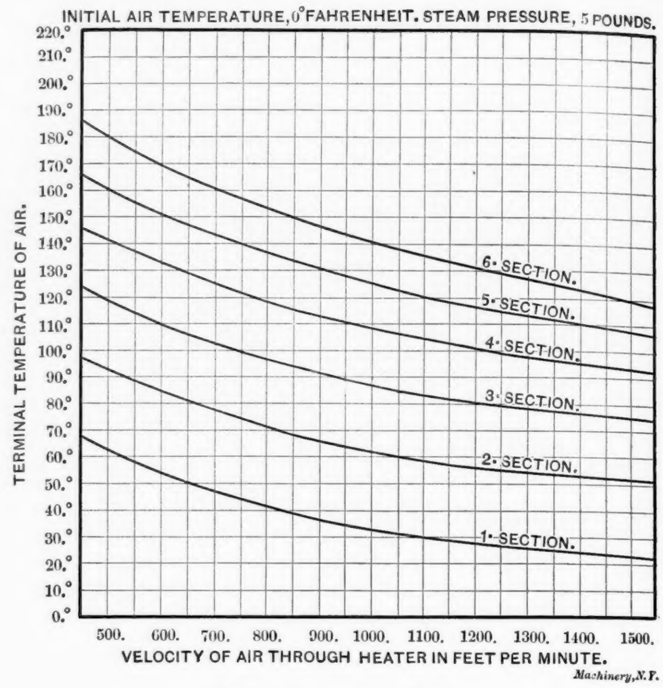


Fig. 12. Temperature Chart.

In making the pipe connections to a heater of this kind, a main or header is usually run along one side, from which branches of the proper size are carried to the different sections. The arrangement of the returns should correspond in a general way with the supplies.

The main header should be properly drained, and the condensation from the heater tapped to a receiving tank, or returned to the boilers by gravity if the heater is overhead. If possible, the return from each section should be provided with a water-seal two or three feet in depth. This is because condensation is greater in the outer sections, resulting in a slight difference in pressure which causes the return water from the inner sections to be drawn into the outer ones,

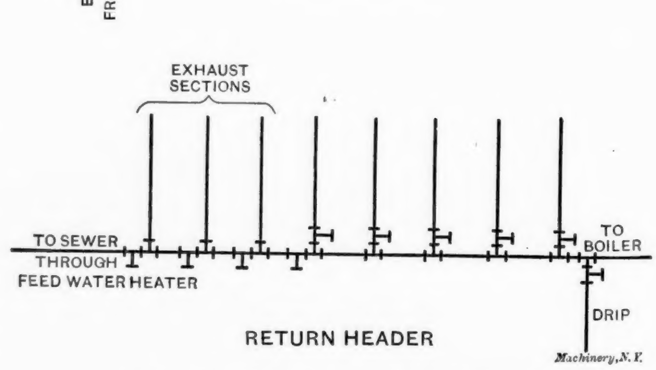


Fig. 13. Diagram of Heater Pipe Connections

thus producing water-hammer and imperfect circulation of steam.

In the case of overhead heaters the returns may be sealed by the water-line of the boiler or by the use of a special water-line trap, but vertical pipe heaters resting on foundations near the floor are usually provided with siphon loops, extending into a pit. If this arrangement is not convenient, a separate trap should be placed on the return from each section.

The main return, in addition to its connection with the boilers or pump receiver should have a connection with the sewer

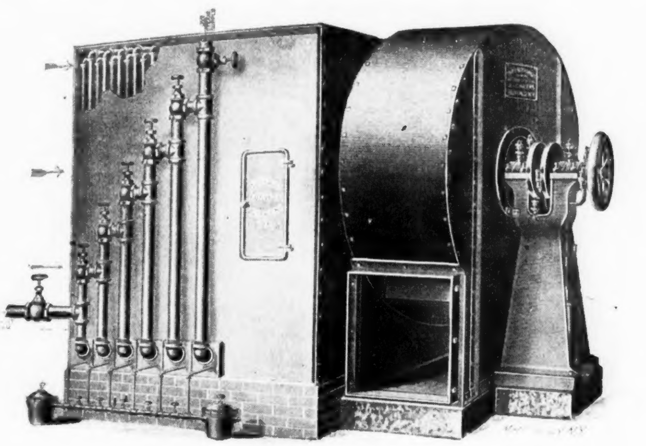


Fig 14. Buffalo Forge Company's Heater.

for blowing out when steam is first turned on. Sometimes each section is provided with a connection of this kind.

Large automatic air valves should be connected with each section, and it is well to supplement these with a hand pet-cock, unless individual blow-off valves are provided as described above. If the fan is driven by a steam engine, provision should be made for using the exhaust in the heater, and part of the sections should be so valved that they may be supplied with either exhaust or live steam as desired. Fig. 13 shows in diagram a method of making the connections for a heater in which three of the sections may be used in this way. Another way of accomplishing the same result is shown in Fig. 14, which shows a heater made by the Buffalo Forge Company. In this arrangement all of the sections are interchangeable.

The sizes of the mains and branches are often fixed by the tapping of the heater sections. The following Table III, based on experience, has been found to give satisfactory results where the apparatus is near the boilers:

TABLE III.

Square feet of Surface.	Diameter of Steam Pipe.	Diameter of Return.
150	2″	1¼″
300	2½″	1½″
500	3″	2″
700	3½″	2″
1000	4″	2½″
2000	5″	2½″
3000	6″	3″

From 50 to 60 square feet of radiating-surface should be provided in the exhaust portion of the heater for each engine horsepower, and should be divided into at least three sections, so that it can be proportioned to the requirements of different outside temperatures.

The condensation from the exhaust sections contains oil from the engine and should not be returned to the boilers; much of its heat, however, can be saved by passing it through a feed water heater. A simple heater for this purpose may be made of a piece of 8-inch pipe, 7 or 8 feet in length, with flanged heads, and containing a coil made up of four lengths of 1-inch brass pipe. The feed to the boilers is made to pass through the coil, while the space around it is filled with hot condensation. A similar heater is sometimes placed in the exhaust pipe from the engine, for use when exhausting outboard in mild weather. After passing through the feed water heater the condensation should be trapped to the sewer.

FUNDAMENTAL IDEAS ON THE STRENGTH OF BEAMS.—1.

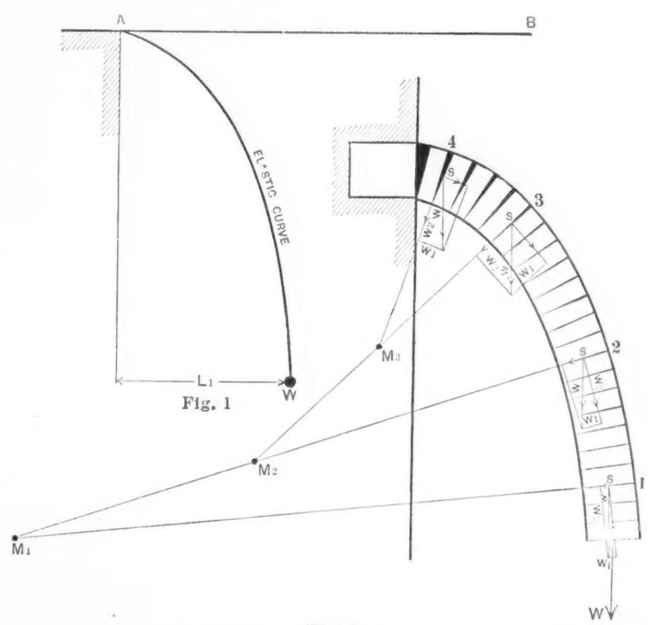
JOHN D. ADAMS.

The one part of the mathematics of mechanical engineering that is most universally important in construction and design, is the part pertaining to the strength of materials subjected to bending. To those familiar with the methods of calculus, the whole matter is comparatively simple, but to the many who are not mathematically inclined, the subject is quite confusing, and a practical working understanding seems difficult to attain. The fundamental ideas which underlie the theory of elasticity as applied to flexure or bending, when depicted graphically in a more or less exaggerated form, can be conveyed to the mind with much less effort and more satisfactorily than by a pure mathematical treatment. The following are the principal points which the writer attempts to deal with in this way, and which form the basis of the general formulas for the strength of a beam subject to bending:

1. The sum of the elementary tensile stresses on one side of the neutral axis is equal to the sum of the elementary compressive stresses on the other side.
2. The stress at any point is proportional to the distance of that point from the neutral axis.
3. The neutral axis of any section passes through the center of gravity of that section.
4. The ability of a section to resist bending depends upon the moment of inertia of that section.
5. The formulas for bending are only applicable for stresses below the elastic limit.

Each of these points will be dealt with separately, but before so doing it would be well to observe just what occurs when a beam is bent.

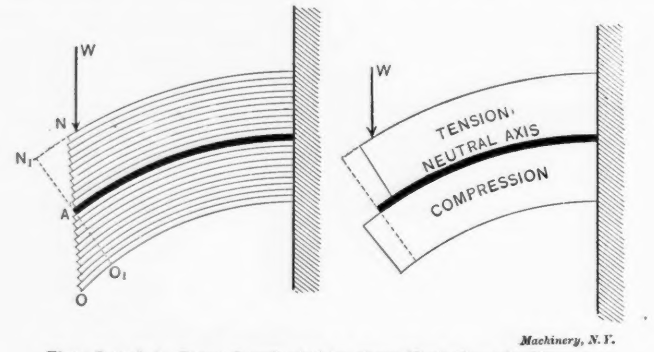
If we take a strip of paper about ½ inch wide and allow it to project horizontally about 3½ inches over a corner, as at *A*, Fig. 1, it will stick out approximately as shown by the line *A B*. But if we attach a small weight, *W*, at point *B*, the paper will bend as shown, to a shape which is known as the "elastic curve." In Fig. 2 we have the same curve but the thickness is exaggerated for the sake of clearness. The



Figs. 1 and 2. Shape Assumed by, and Stresses in, Deflected Beam.

first thing we note is that the curve flattens out as we approach the free end, so that if we were to draw radii from different points, they would gradually become shorter and intersect one another at points M_1, M_2, M_3, etc. We also note that whereas the top and bottom sides of the beam were originally of the same length, there is now considerable difference. This difference is clearly shown by dividing the bottom sides into a number of equal parts and laying off parallel strips on the side of the beam, the spaces between which indicate the uniform increase in length as we approach the top side of the beam. It is also evident that if for some

reason this beam were to break near the lower end, it would do so on account of the tension and not by bending; whereas if it were to break near the attached end it would be due to bending and not to tension. The reason for this will be seen by finding the forces at the center of the radial planes 1, 2, 3, 4, by means of the familiar principle of the parallelogram of forces. In each place we have a constant vertical force, W, tending to produce bending around S; a tensile force, W_1, tending to tear off the portion of the beam below S; and a shearing force W_2, tending to shear off the part of the beam below S. As the resultant W is always vertical and



Figs. 3 and 4. Beam Laminated to show Variations in Stresses

constant, the shearing component W_2 increases and the tensile component decreases as we approach the point of support. In ordinary practice the deflection of a beam is so small that we may take the shearing force as equal to the load W, and neglect the tensile component altogether. We may also consider the length of the beam when straight, L, as being equal to L_1.

Equality of Stresses on Either Side of the Neutral Axis.

If we take a number of strips of Bristol board of equal length, pile one upon the other, and subject them to bending, we have the result shown in Fig. 3. We note that the length of any layer remains practically unchanged. If, instead of this, we were to glue these strips all together, or, rather, substitute one solid piece and bend it to the same extent, the end would occupy the position indicated by the dotted line $N_1 O_1$. We note, therefore, that the material above the black line is stretched so as to fill the space $N N_1 A$, whereas the material below the line is compressed to the extent of the triangle $O O_1 A$. If, while the solid piece is in this bent position, the gluing were to give way at each side of the black layer, the result would be as shown in Fig. 4, the upper portion contracting and the lower one expanding. But since the black layer remains the same length (and therefore not under any tensile or compressive strain), whether the beam be composed of layers or one solid piece, these two opposite forces (*viz.*, tension above the line and compression below) must be exactly equal. If they were not equal at any point on this line, this point would of course move in the direction of the greater force. Since the neutral axis is defined as the line where the fibers are neither stretched nor compressed, it must follow that the sum of tensile stresses on one side of this line equals the sum of the compressive stresses on the other side.

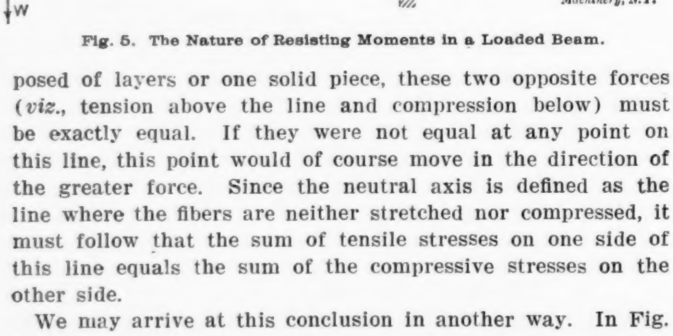


Fig. 5. The Nature of Resisting Moments in a Loaded Beam.

We may arrive at this conclusion in another way. In Fig. 5 let Q and Q' represent the sums of the tensile and compressive forces. Since the beam is in equilibrium when bent by the load W, the moments around the point b considered as a fulcrum must also be in equilibrium. Therefore,

Moment $W L = Q$ multiplied by its leverage, $a b$.

Similarly considering point a as a fulcrum, we have:

Moment $W L = Q'$ multiplied by its leverage, $a b$.

Therefore $Q = Q'$ .... (1)

Unit Stress Proportional to Distance from Neutral Axis.

The next point to consider is the fact that the stress in any fiber is proportional to its distance from the neutral axis.

We note that in Fig. 3 certain fibers or portions of the beam have changed their lengths. Experiment has developed the fact that if we take an iron bar and subject it to a certain force, it will become extended or compressed an equal amount, according to whether the force be one of tension or compression; and that if we double this force the extension or compression, as the case may be, is also doubled. In other words the extension or compression in a certain rod is directly proportional to the force applied, and equal for equal forces. If we lay off on squared paper the stresses in pounds per square inch and the corresponding strains produced in the material, the relation between the two will be indicated by a straight line, as shown in Fig. 6. This illustrates what is known as "Hook's law."

In Fig. 2 we note that the fibers lying originally between any two parallel planes taken at right angles to the length of the beam, are, when the beam is bent, found to lie between the same two planes, opened out to include an angle corresponding to the curvature at that point. That is, as we move

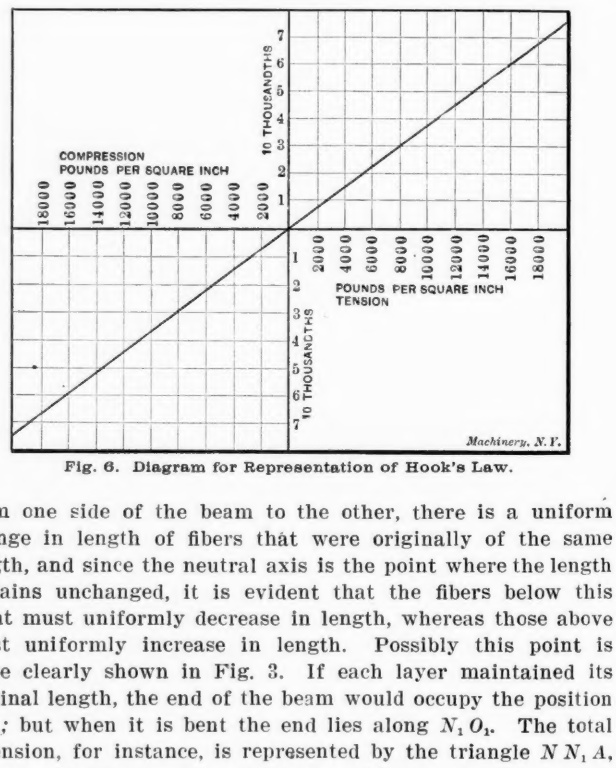


Fig. 6. Diagram for Representation of Hook's Law.

from one side of the beam to the other, there is a uniform change in length of fibers that were originally of the same length, and since the neutral axis is the point where the length remains unchanged, it is evident that the fibers below this point must uniformly decrease in length, whereas those above must uniformly increase in length. Possibly this point is more clearly shown in Fig. 3. If each layer maintained its original length, the end of the beam would occupy the position $N O$; but when it is bent the end lies along $N_1 O_1$. The total extension, for instance, is represented by the triangle $N N_1 A$, and the extension of any layer is evidently directly proportional to the distance of that layer from the neutral axis. Since by Hook's law the deformation is directly proportional to the stress, it follows that the fiber stress in any layer is also directly proportional to the distance of that layer from the neutral axis. In Fig. 5 let y be the distance to any layer or fiber from the neutral axis, and f the stress in the fibers at the maximum distance from the neutral axis, then we have:

Stress in any fiber at distance $y = \dfrac{fy}{Y}$ .... (2)

* * *

Poorly ventilated subways evidently belong to those things which are inexcusable in this world in view of the fact that the installment of the ventilating equipment of the Boston Subway, by which satisfactory atmospheric conditions have been secured, has been carried out at the cost of less than 1 per cent of the cost of the subway itself.

ECONOMICAL PRODUCTION OF COMPRESSED AIR.*

The work performed by an air compressor is, broadly speaking, that of increasing pressure of the air (or other gas) from a lower to a higher stage by reducing its volume or compressing it into smaller space. Usually in air compressor practice the lower or initial pressure is the "atmospheric pressure" at point of location of compressor, while the higher or terminal pressure is fixed by the requirements of the particular case, and may be anywhere from 10 to 30 pounds (gage pressure) per square inch as in blowing engine practice, up to 80 to 100 pounds per square inch for rock drills, pneumatic tools, etc., and up to 1,500 to 2,000 pounds per square inch, or even higher, for special purposes. Compressors which work against pressures under 30 pounds gage are usually called blowing engines. Atmospheric pressure (or zero gage pressure) equals 14.7 pounds absolute pressure per square inch at sea level (equivalent to 30 inches barometer) and becomes less as the altitude above sea level increases, the decrease being approximately one-half pound, or one inch in mercury column, for each 1,000 feet increase in altitude. As the work of compression depends upon the initial and terminal absolute pressures (absolute pressure being equivalent to gage pressure plus atmospheric pressure) the altitude at which the compressor is to work is of great importance and must be considered.

When air is compressed into a smaller volume, if the temperature remains constant, the pressure increases directly in proportion to the decrease in volume; that is, if the volume is one-half, the pressure will be doubled; if one-third the pressure will be trebled, and so on for any decrease in volume. There is, however, another and most important factor in the problem which must be considered in all cases except the lowest terminal pressures, *viz.*: the increase in temperature and consequent increase in volume due to the heat developed during compression. When air is compressed, the work done during compression is converted into heat, which must be taken up by the air compressed, the result being a very material rise in its temperature and increase in its volume, thus adding largely to the work required to be done. Without going into a theoretical discussion of this factor in the problem, a brief statement of facts will show its great importance.

Saving in Power by Cooling During Compression.

If air at atmospheric pressure and 60 degrees F. could be compressed to 100 pounds gage pressure and all the heat due to the work of compression taken away as fast as generated, so that the temperature during compression would remain constant, the mean effective pressure during one stroke of the air piston would be 30.2 pounds. If, on the other extreme, none of the heat due to the work of compression is taken away, the mean effective pressure during the stroke will be 41.6 pounds and the terminal temperature will reach 485 degrees F. As the power required for compression is directly proportional to the mean effective pressure, it will be seen that the additional power required in the latter case is 37½ per cent of that in the former. In practice neither extreme can be reached, for it is impossible to completely cool the air during compression, and, on the other hand, some of the heat of compression will be radiated; but the lower extreme is the ideal, and the nearer it can be approached, the more economical the compressor.

Removing Heat of Compression.

Various plans for taking away the heat during compression, such as injecting a spray of water into the cylinder, circulating cooling water through the piston and around the heads and cylinder barrel, etc., have been tried. The use of the cooling spray, or so called "wet compression," has long since been abandoned, as has also the plan of circulating water through the piston, for the disadvantages more than offset the possible gains. Cylinder heads and barrels are still water-jacketed, not so much on account of the heat that can be taken from the air as to keep the cylinder cool enough for proper lubrication. The most effective means for taking away the heat of compression and reducing the amount of power required consists in dividing the compression into two or more stages, depending upon the terminal pressure desired, and cooling the air as much as possible between stages by means of suitable cooling apparatus, the water-jacketing of the cylinders and heads being retained for the reason above stated. Where the work of compression is done in two or more cylinders, it is customary to so fix the ratio of cylinder volumes as to divide the work equally between the cylinders. By using two-stage compression and cooling the air between the stages to its initial temperature (60 degrees F.), without considering the cooling by water jacketing, it is possible to reduce the mean effective pressure to 35.5 pounds as compared to 41.6 pounds in the case above given, which is equivalent to a saving of 15 per cent. At the same time the terminal temperature will be only 245 degrees F. instead of 485 degrees F. In practice the saving may be a little less and the terminal temperature somewhat higher, as the initial temperature in both cylinders will usually be higher than 60 degrees F., but, after making all allowances, the figures afford an indisputable argument in favor of two stage compression.

TABLE I. MEAN EFFECTIVE PRESSURE AND INDICATED HORSEPOWER.

Required to Compress a Cubic Foot of Free Air (Adiabatically) from Atmospheric Pressure (14.7 pounds) to Various Gage Pressures. Initial Temperature of Air in Each Cylinder taken as 60 Deg. F. Jacket Cooling not Considered.

			Single Compression.		Two Stage Compression.		
Gage Pressure, Pounds.	Absolute Pressure, Pounds.	Ratio of Compression.	Mean Effective Pressure, Friction Included.	Indicated H P. per cubic foot, Free Air Friction Included.	M. E. P. per square inch Reduced to Low Pressure Air Cylinder Friction included.	Indicated H P. per cubic foot, Free Air Friction Included.	Per Cent of Power Saved by Two-stage over Single Compression (Theoretical).
5	19.7	1.34	5.12	.022	.....	....	....
10	24.7	1.68	9.44	.041	.....	....	....
15	29.7	2.02	13.17	.057	.....	....	....
20	34.7	2.36	16.44	.071	.....	....	....
25	39.7	2.70	19.47	.085	.....	....	....
30	44.7	3.04	22.21	.096	.....	....	....
35	49.7	3.38	24.72	.108	.....	....	....
40	54.7	3.72	27.05	.118	.....	....	....
45	59.7	4.06	29.21	.127	.....	....	....
50	64.7	4.40	31.31	.136	.....	....	....
55	69.7	4.74	33.23	.145	.....	....	....
60	74 7	5.08	35.10	.153	.....	....	....
65	79.7	5.42	36.91	.161	.....	....	....
70	84.7	5.76	38.59	.168	33.71	.147	12.7
75	89.7	6.10	40.25	.175	34.99	.153	13.0
80	94.7	6.44	41.80	.182	36.15	.158	13.5
85	99.7	6.78	43.27	.189	37.32	.163	13.8
90	104.7	7.12	44.71	.195	38.36	.167	14.2
95	109.7	7.46	46.12	.201	39.41	.172	14.5
100	114.7	7.80	47.46	.207	40.48	.176	14.7
110	124.7	8.48	50.09	.218	42.34	.185	15.4
120	134.7	9.16	52.53	.229	44.20	.193	15.9
130	144.7	9.84	54.87	.239	45.83	.200	16.5
140	154.7	10.52	57.08	.249	47.46	.207	16.9
150	164.7	11.20	59.18	.258	48.99	.214	17.2
160	174.7	11.88	....	....	50.39	.219	....
170	184.7	12.56	.....	....	51.66	.225	....
180	194.7	13.24	....	....	52.95	.231	....
190	204.7	13.92	.....	....	54.22	.236	....
200	214.7	14.60	.....	....	55.39	.241	....
250	264.7	18.00	.....	....	60.76	.264	....
300	314 7	21.40	.....	....	65.20	.283	....
350	364.7	24.81	.....	....	69.16	.301	....
400	414.7	28.21	.....	....	72.65	.317	....
450	464.7	31.61	.....	....	75.81	.329	....
500	514.7	35.01	.....	....	78.72	.342	....
550	564.7	38.41	.....	....	81.30	.354	....
600	614.7	41.81	.....	....	83.75	.364	....

Clearance.

Another important factor in compressor design is the clearance in the compressor cylinders. It is not possible to run a compressor without some space between the piston and cylinder head at the end of the stroke, and in addition to this space there is the volume in the inlet and discharge passages between the valves and cylinder space. It is the aim of all good designers to make this clearance space as small, in proportion to the volume swept through by the piston, as pos-

* Contributed by the Allis-Chalmers Co., Milwaukee, Wis.

sible; for at the end of the stroke the clearance space is filled with air at the terminal pressure which must expand back to the initial pressure before the inlet valve is opened. This is particularly important in single stage compression, as, at discharge pressures ordinarily used, the expansion of the compressed air in the clearance space back into the cylinder seriously affects the volumetric efficiency of the compressor. If the volume swept through by the piston in one stroke is one thousand cubic inches and the clearance volume is twenty cubic inches, the compressor has two per cent clearance. In this case if the discharge pressure is 75 pounds gage (89.7 pounds absolute) and the initial pressure is atmospheric pressure at sea level (14.7 pounds) the air in the clearance space will expand to six times the clearance volume, or to 120 cubic inches, and, as the clearance volume is only 20 inches, the remaining 100 cubic inches must be in the cylinder; that is, the piston must travel back ten per cent of the return stroke before opening the inlet valve, and the actual room for the admission of free air is only 1000 — 100 = 900 cubic inches; or, as commonly stated, the volumetric efficiency of the compressor is only 90 per cent.

TABLE II. SHOWING THE RELATIVE VOLUMES OF COMPRESSED AIR AT VARIOUS PRESSURES.

Gage Pressure, Pounds.	Volume of Free Air Corresponding to One Cubic Foot of Air at Given Pressure.	Corresponding Volume of One Cubic Foot of Free Air at Given Pressure.	Gage Pressure, Pounds.	Volume of Free Air Corresponding to One Cubic Foot of Air at Given Pressure.	Corresponding Volume of One Cubic Foot of Free Air at Given Pressure.
0	1.00	1.00	70	5.762	.1735
1	1.068	.9356	75	6 102	.1638
2	1.136	.8802	80	6.442	.1552
3	1.204	.8305	85	6.782	.1474
4	1.273	.7861	90	7.122	.1404
5	1.34	.7462	95	7.462	.1340
10	1.68	.5951	100	7.802	.1281
15	2.02	.4949	110	8.483	.1178
20	2.36	.4236	120	9.170	.1090
25	2.7	.3703	130	9.843	.1016
30	3.04	.3288	140	10 52	.0950
35	3.38	.2957	150	11.20	.0892
40	3.72	.2687	160	11.88	.0841
45	4.06	.2462	170	12.56	.0796
50	4 40	.2272	180	13.24	.0755
55	4.74	.2109	190	13.92	.0712
60	5.08	.1967	200	14.60	.0684
65	5.42	.1844	...	.....	.....

Capacity.

It is the common practice of compressor builders to call the free air capacity of their machines the volume theoretically swept through by the piston, without making any deductions; that is, if the area of the piston is two square feet and it travels 500 feet per minute, the capacity is called 1,000 cubic feet per minute. It will readily be seen that in the case above cited, if the clearance is two per cent., the actual capacity is only 900 cubic feet per minute, and if 1,000 cubic feet is wanted, the compressor must be speeded up to 555 feet per minute. It may be stated in this connection that in the majority of the compressors in daily use the clearance exceeds two per cent and the volumetric efficiency is less than ninety per cent. The clearance also adversely affects the efficiency of the machine, for, in addition to the loss from greater friction on account of the increased speed required for a given actual capacity, the air in the clearance space in expanding to the initial pressure never gives back quite as much power as was used in compressing it. Inasmuch as with any given diameter and travel of piston the clearance space is practically a constant quantity, the longer the stroke the less the percentage of clearance. If a cylinder of 30 inches diameter by 60 inches stroke has one and one-half per cent clearance and the stroke is shortened one-half, *i. e.*, to 30 inches, the percentage of clearance will be doubled, or three per cent. It is therefore better to get the required capacity by using a small diameter and long stroke rather than larger diameter and shorter stroke, even if the advantages of greater reliability in operation, durability and lower cost of maintenance and repair, arising from slower rotative speed for a given piston travel, are not considered. As a matter of fact these advantages, together with the increased efficiencies, will more than offset the disadvantages arising from higher first cost, increased floor space and greater expense of installation.

The loss of volumetric efficiency due to clearance is less in two stage than in single stage compressors, because for any given capacity the first or low-pressure cylinder of the two stage machine is practically of the same size and has the same percentage of clearance, while the terminal pressure is much lower; consequently the expansion back into the cylinder volume is much less and the volumetric efficiency higher. This fact affords another argument for two stage compressors.

Initial Heating.

Another factor affecting compressor capacities and efficiencies merits careful consideration. It is the common practice not only to rate the capacity at the full volume swept through by the piston, but to assume that the cylinder is filled at the beginning of the stroke with air at full atmospheric pressure and at no higher temperature than the outside source of supply. A moment's consideration will show that such ideal conditions are impossible of attainment. In the first place, even with an unobstructed inlet passage, air will not flow into the cylinder without some difference in pressure to force it in, and when, as in many compressors, the inlet valves are of the spring weighted poppet type, this difference as to its effect upon capacity and efficiency becomes a serious matter. Then, again, the entering air comes in contact with the cylinder walls and clearance surfaces which have become highly heated from the compression in the preceding stroke, and is thereby heated to a higher temperature than before entering. This not only reduces the volume of free air at the outside temperature which can be handled, but also raises the terminal temperature of compression. The latter effect may become cumulative, for the higher the terminal temperature, the hotter the surfaces become, and the more the entering air is heated, resulting in still higher terminal temperature. In such cases where the water-jacketing is inefficient or the water circulation becomes interrupted, this cumulative effect may result in heating the compressor cylinder to a dangerous degree. We recall one instance of a small high-speed single stage compressor which, while working in a rather dark room against eighty pounds discharge pressure, became so heated as to show a dull red. It is essential to good economy that the air be brought to the compressor and gotten into the cylinder with as little heating as possible. To accomplish this the inlet ports should be short and direct and the air admitted in a solid stream and not cut up into thin sheets. Admitting the air through a hollow piston and piston rod, or straining it through metal guards which are frequently used to prevent poppet inlet valves from getting into the cylinder in case of breakage of valve stems, manifestly results in undue heating and consequent loss. In this matter of initial heating of the air, the two stage compressor has a marked advantage over the single stage, because the terminal temperatures are much lower, consequently the cylinder walls and clearance surfaces do not become so highly heated and the transfer of heat to the incoming air is much slower.

TABLE III. RELATIVE VOLUMETRIC EFFICIENCIES AT VARIOUS ALTITUDES ABOVE SEA LEVEL.

Altitude Above Sea Level, in Feet.	Barometer, in Inches.	Percentage of Volumetric Efficiency.	Decreased Power Required, 80 pounds, Single Stage, per cent.
0	30.00	100	0.000
500	29.45	98.5	.015
1,000	28.90	97	.025
1,500	28.35	95.5	.04
2,000	27.78	94	.05
3,000	26.75	91	.07
4,000	25.75	88	.09
5,000	24.78	85	.11
6,000	23.86	82	.13
7,000	22.97	79	.14
8,000	22.10	76	.16
9,000	21.30	73	.17
10,000	20 60	70	.18
11,000	19.75	68	.20
12,000	19.00	65	.21
13,000	18 30	62	.23
14,000	17 60	59	.24
15,000	16.95	57	.24

SPECIAL TOOLS FOR MUSICAL INSTRUMENT WORK.

S. J. PUTNAM.

The accompanying halftones show a patent guitar and mandolin head "machine" and special screw machine box-tools designed by the writer for the Hinzmann & Putnam Mfg. Co., New York City, during the period from 1898 until Mr. Hinzmann's death in 1904. The patented improvement on the open plate head machine, Figs. 4, 5, 6 and 7, consists of the combination whereby the wormwheel and stem *A*, Fig. 4, can be made in one piece instead of three, which means a saving of 192 parts in every dozen pairs of machines. The closed half plate machines, Figs. 1 and 8, and the closed whole plate machines, Figs. 2 and 3, although of unique design, are not patented. The Hindley form of worm *B*, Fig. 4, is used in order to have the full benefit of the difference in diameter of the stock and the diameter of the journals for a thrust bearing. When the diameter at the bottom of the thread is the same as that of the journal, and the thread is run straight across instead of on a radius, it will cut half of the throat collar away. Another point is the cost of cutting the thread. I suggested a box tool that could be used in a regular hand screw machine and would cut a Hindley worm of our required dimensions (7/32 inch in diameter, and 0.1 inch pitch) in record breaking time. However, we sent a sample screw to a well-known machine tool manufacturer to see what regular ways and means could do, and a screw machine with special leader-bar attachment was recommended for making it; an estimate was given that the machine would make 350 pieces (from rod brass) in ten hours. This did not look good to us, so the box tool shown in Fig. 10, which will be described later, was made instead.

Referring again to the wormwheel details: Other makes have a square hole through them and the end of the stem is milled square to suit; a hole is drilled and tapped in the end of the stem which passes through the plate, and a screw with a head large enough to cover the square hole in the wormwheel is used to pull the wheel down against the plate. The stem of our wormwheel *A*, Fig. 4, has a groove flush with the shoulder of the wormwheel. The width of the groove is made to correspond with the thickness of the plate *D*, Figs. 4 and 5, and the diameter at the bottom of the groove takes its bearing in the elongated slots shown at *E* in the plates Figs. 4 and 5. One end of the slot is made large to allow the barrel or stem of the wormwheel to pass in when assembling. The lugs *C C* which form the bearings for the worm are assembled on the worm and riveted to the plate through square holes at *F F*, Figs. 4 and 5, thus preventing the wormwheel from getting away from the end of its slot bearing. The metal for plates *D*, Figs. 4 and 5, is ordered in long strips and the fancy crown-shaped ends on plate *D*, Fig. 5, are made by a punch and die when cutting it up to the required length. All of the holes in the plate are made by a piercing punch and die in one operation.

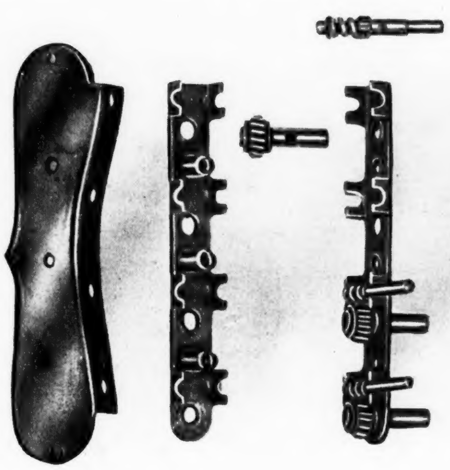
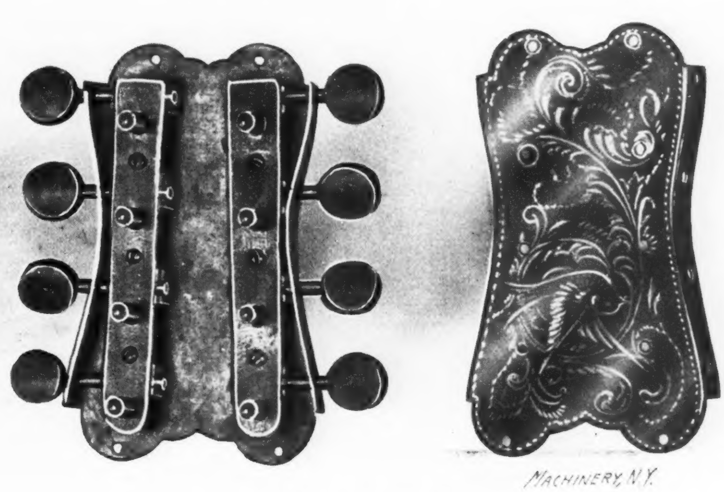


Fig. 1. Half-plate Mechanism Dismounted.



Figs. 2 and 3. Whole-plate Mechanism.

A Brass Wormwheel and the Way it was Made.

When we first started, all the metal parts were made of brass and the wormwheels were hobbed; the hob used was over 3 inches in diameter, 2.6 inches lead, 0.1 pitch (26 multiple threads), which made our wormwheel (which was 13/32 inch diameter with 12 teeth) resemble a spiral gear. This fact was an advantage when assembling, for the lugs carrying the worm could go straight down to the shoulder and be riveted without difficulty. Another reason for using a large hob was that we would need it in making the cutter to be used in the box tool for cutting Hindley worm threads.

In order to cut this 2.6 inches lead thread on our lathe, we compounded the gears by making a special gear for the inside end of the change gear spindle that would mesh with the gear on the cone pulley, and so on through the back gear quill to the gear on the main spindle. This main spindle gear had 78 teeth, and thus we got 26 multiple threads by removing an intermediate gear after cutting one thread and then turning the spindle a distance of 3 teeth on this main spindle gear, which gave the correct indexing for the next thread. The flutes in the hob were narrow and close together so that there would always be at least two rows of teeth cutting. The hob when finished was mounted upon a vertical shaft, and a spiral gear of the same diameter and pitch as the hob was fastened to the same shaft just above the hob. Tangent to this spiral gear and in mesh with its teeth was a horizontal shaft with a 12-tooth spiral gear, this being the number of teeth wanted in the wormwheel to be hobbed. It was only necessary to construct a frame that would swing upon this shaft as a center and having another shaft parallel with it and opposite the hob, each of the parallel shafts having a spur gear connected by an intermediate gear. The last shaft had a hole bored in one end the size of the stem of the wormwheel blank. Across this shell end of the shaft a slot was milled to drive the work wheel by means of a slightly tapered pin which was thrust into the hole used for fastening the strings of the instrument through the stem of the wormwheel. The stem of the wormwheel to be cut is slipped into the holder while the machine is running, and a hardened steel forked plate latch, pivoted on the side of the swinging frame, drops into the slot of the wormwheel stem, when a cam lever carries it and the swinging frame in until it reaches a stop. The wormwheel teeth are therefore cut with the wheel running in its own bearing. The cam lever is now released, which allows the frame carrying the finished wormwheel to swing away from the hob; the latch is then raised and the wormwheel drops out into the pan.

A Turret Tool for Knurling the Teeth of Steel Wormwheels.

The rig described worked well on brass and it was used for more than a year. We would have used it longer only for the good reason that we no longer made the wormwheels of brass. It was in the year 1899 and brass came high. The proposition of making all parts of steel then presented itself and was adopted, using nickel flat finish. The wormwheel

was superseded by a spiral steel gear, the teeth of which were knurled in the screw machine before cutting the piece off the rod. The turret tool shown in Fig. 9 accomplished this part of the operation in a very satisfactory manner. The body *G* has a stem *H* which is fitted to the hole in the turret. The jaws *I*, *J* and *K* have shafts through their entire length with hardened and tempered spiral gears keyed to the

Figs. 4, 5, 6 and 7. Construction and Details of Improved Instrument "Machine."

front ends, and also a set of straight cut gears of the same pitch and diameter at the other end. The straight cut gears are in mesh with a central pinion with twelve teeth and of the same diameter as the spiral gear to be "knurled." The meshing of this pinion and the straight-cut gears prevents the spiral gears from getting out of time. The jaws are fitted to slots in the body *G*, and, with pins *L* to swing upon, are given enough movement to allow the spiral gear "knurls" to pass over the blank to be cut.

The jaws are held open by open coil springs supported by U-shaped frames which rest on body *G* and have studs passing through them into the jaws as at *M*. The knurls are forced into the work by the clamp screw *N* and the depth of cut is regulated by the check nuts *O O* which stop against the band clamp *P*. While knurling, a stream of oil passes through the tube *Q* to the knurls. We have used both hot and cold rolled steel for these wheels with no difficulty from the teeth

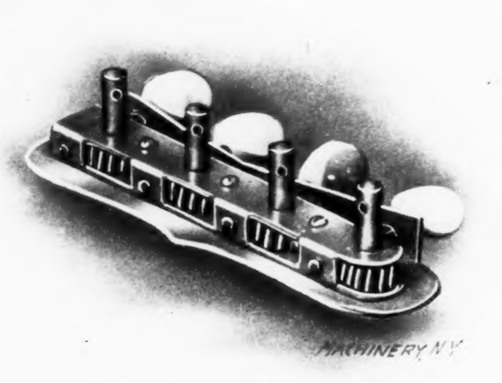


Fig. 8. Half-plate Machine Assembled.

breaking. The tool that formed the blank is run in again after the knurling is done to trim up the ends of the teeth, after which the piece is cut off the rod.

Cutting a Hindley Form Worm in the Turret Lathe.

The tool shown in Fig. 10 is used for threading the Hindley worm. The cutting of the thread is the first operation on the blank rod. The cutting tool is an endless chaser revolving in front of the screw; it is fed straight into the side of the stock and the instant the required depth is reached the worm thread is finished. The tooth contact attained, although considered good for the purpose for which these machines are used, is less than that of an ordinary worm and wormwheel. The chaser tool, which might be called a hob, has twenty teeth, and the worm would therefore only be a Hindley worm when used with a wormwheel of twenty teeth, whereas we put it with a spiral gear of twenty teeth. This is done in order to reduce to a minimum the liability of waste in time when assembling. This is very essential, as the greatest demand for these machines is from manufacturers of the cheapest grade of instruments, and to this class of buyers competition has brought prices down to a surprisingly low figure.

The box tool is held in the turret by the stem *R*, and in the front end of this stem there is a hardened 60-degree center which forms a thrust bearing for the worm shaft *S*. This shaft has another bearing in the block at *T*, and a driving head is pinned to the front end, a detail of which is shown in Fig. 11. The distance from the point of one tooth in this driving head to the point of the tooth opposite is about 0.020 inch less than the diameter of the stock from which the screw is made. The teeth of the driving head work as an external broach when shoved on the edge of the rod, and it does not matter whether the blank is at rest or revolving, the grooves are always cut straight and parallel. When we were making the screws from brass rod the machine was run at 2,200 revolutions per minute, and was not stopped nor reversed.

The worm of the driving shaft is of the same diameter and pitch as the thread to be cut and is in mesh with a twenty-tooth wormwheel, which is a part of the sleeve and first gear *U* of the train of gears to the cutter arbor *V*. The sleeve runs on a post which is driven into the body of the box tool and extends through on the under side for the lower bearing of the swinging frame *W*. The block containing the adjust-

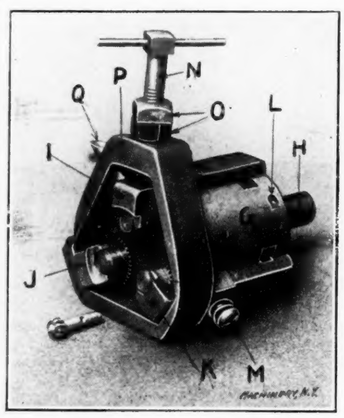


Fig. 9. Turret Tool for Wormwheel.

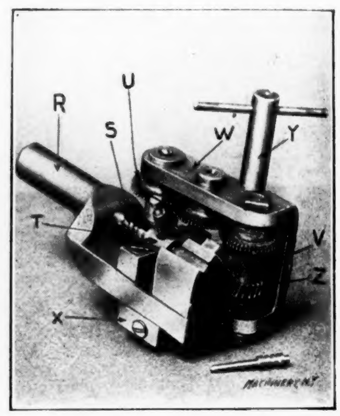


Fig. 10. Turret Tool for Worm.

able stop screw *X* for depth of cut also supports the downward thrust of the cut on the front end of the swinging frame. The shaft *Y*, with handle, has two eccentrics which operate against the swinging frame on the upper and lower sides. This shaft has a long bearing in a boss on the side of the body of the box tool and the swinging frame is held against it by a spring so that after the cut is made, the frame is released automatically. The cutter arbor runs on adjustable screw centers and the top face of the cutter *Z* is set flush to a radial line of the work. Opposite the cutter is a steady rest fastened to a block on the body of the box tool.

Comparative Costs of Steel and Brass Worms.

While making the worm screws of brass, the average number of pieces produced per ten-hour day was 1,500 and the greatest number in one day was 1,700. When making the worm screws of steel the average number of pieces produced in ten hours has been 950, and the greatest number in one day has been as high as 1,100. When steel is 3¾ cents per pound and brass rod 14 cents per pound there is not much choice from a financial point of view which metal to use, but when the price of brass rod goes up to say 18½ cents there would be a difference of 7 cents per hundred in favor of using steel In arriving at this conclusion I am charging 15 cents per hour against the screw machine man's time for his share of the company's running expenses. This amount will of course vary in different departments, or in the

same department at different times, according to the number of men required to do the business on hand. That is to say that the running expenses in the line of non-producers' salaries (from the president of the company down) power supplies, interest on investment, advertising, etc., will not vary much. We will say for example that in the department where these worm screws are made there are seventy-five workmen (not including foreman, draftsman, clerks, floor boy, or any other of the so-called non-producers). It will be seen from this that the department is charged with $11.25 per hour for its share of the running expenses of the company. In case it was found necessary to increase the number of workmen to one hundred the charge per hour against each man in order to cover this amount would only be 11¼ cents, whereas if the

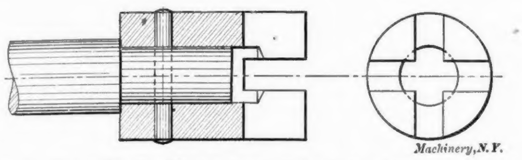


Fig. 11. Drive for the Mechanism of the Tool shown in Fig. 10.

force should be cut down to fifty on account of business being dull, the price per hour would come up to 22½ cents. Whether this system of figuring cost prices is very extensively used or not, I cannot say, but it is by no means new, however. In order to get down to facts for aid in the choice of material, a few figures of comparison may be interesting.

Actual cost of 1,000 worm screws of brass, the net price being 14 cents per pound:

Material, 15½ pounds rod brass at 14 cents........	$2.17	
Credit 1¼ pound scrap (chips) at 8 cents.........	.10	
		$2.07
Screw machine operation, piece work at 15 cents per 100		1.50
Charge for running expense 6.6 hours at 15 cents...		.99
Total of actual cost per 1,000 pieces................		$4.56

Actual cost of 1,000 worm screws of steel, the net price of material being 3¾ cents per pound:

Material, 15½ pounds steel wire at 3¾ cents......	.58
Screw machine operation, piece work at 24 cents per 100	2.40
Charge for running expenses 10½ hours at 15 cents	1.58
	$4.56

Actual cost of 1,000 worm screws of brass, the net price being 18½ cents per pound:

Material, 15½ pounds rod brass at 18½ cents......	2.87	
Credit 1¼ pound scrap (chips) at 8 cents.......	.10	
		2.77
Screw machine operation piece work at 15 cents per 100		1.50
Charge for running expenses 6.6 hours at 15 cents.		.99
Total of actual cost per 100 pieces................		$5.26

* * *

In connection with a number of boiler explosions which have taken place lately, some of these, particularly the one at the Lake Shore Collingwood shops, having resulted in fatal accidents, it has been pointed out that in some cases where boiler plate has been condemned by the United States inspection department for use by the government, it has nevertheless been used for boilers sold to private factories. For this reason it is urged that there should be adopted a general law for testing of boiler plate. Such a law would no doubt have good reasons for being passed, particularly if it be true that condemned plate is used to supply customers who are not in a position to themselves test the material in the boilers sold to them.

* * *

During the investigation in regard to the terrible Terra Cotta disaster on the Baltimore & Ohio Railroad, E. W. Kelly, Jr., trainmaster of the B. & O. at Baltimore, when questioned in regard to the hours of employment of men engaged in the handling of trains, stated that local train crews worked during October and November last on an average 16 hours a day for six days a week without a period of rest. In some cases trainmen worked 36 hours without relief, while others worked five and six days at a time on an average of 20 hours per day.

HELPFUL HINTS FOR THE TOOLMAKER.

F. E. SHAILOR.

The old saying that "one never learns the machinist's trade" tempts the writer to set forth a few kinks that will be of benefit to those who have not passed many years in the hard school of experience. The methods as set forth herein are in vogue in the finest toolrooms in this country, in watch factories, and in the manufacture of delicate measuring instruments. The reader may accept them for what they are worth.

Cutting a Smooth Thread.

When cutting threads, one often meets with difficulty in obtaining a smooth thread, such as is required for screw gages and taps. One good way to obtain a smooth thread is to turn the tap nearly to size and harden it; then draw the temper to a "light blue." When turning to size, if the tool does not stand up well, draw still lower, the object being to leave just enough temper in the tap to make the steel firm. By making light chips with a hard thread tool a glossy, smooth thread will result.

Another advantage gained by hardening the tap before finishing is that it will greatly eliminate the chances of the lead changing after the final hardening. A thin lubricant of lard oil and turpentine is an excellent one for thread cutting. When cutting two or more taps it is customary in some shops to rough out both or all the taps, leaving the dogs on them, and for sizing or finishing cut the taps are chased without moving the thread tool. But if the thread tool dulls a trifle

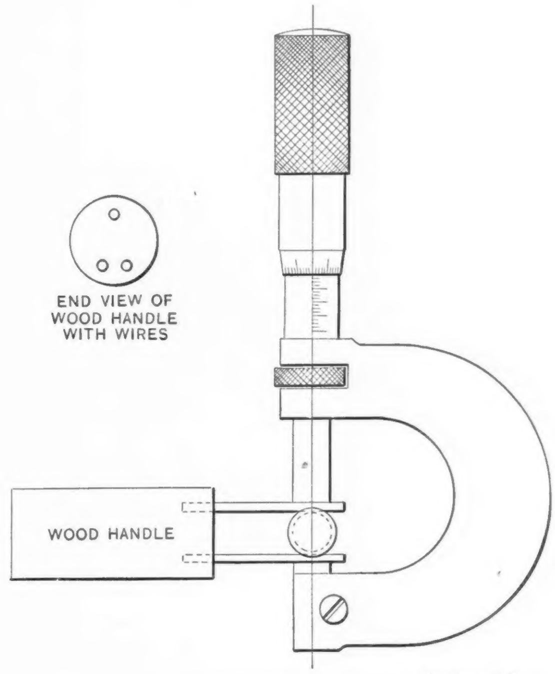


Fig. 1. Holder for Wires when Measuring Taps by the Three-wire System.

when making the finishing cut on first tap, the succeeding taps will not be exactly the same size. A good way to make a number of taps all of one size is to use a tool as shown in Fig. 1. Three fingers of small music wire are fastened in a handle. By placing the wires in the threads on the tap, as shown, and measuring with micrometers over all the wires, the taps to be made can be cut to exactly the same size, using same wires for measuring. If a solid thread tool is used, the cutting point should not project any further than is necessary from the toolpost, which will greatly reduce springing, which is one cause of rough threads, due to tool "digging" in. A curved neck thread tool gives best results, as this style of tool will spring away from the work instead of in.

A Kink on Hardening.

What will greatly reduce the chances of springing in hardening of an irregularly shaped punch or die is to thoroughly anneal same after it has been machined nearly to size. This will, of course, not entirely remove chances for accidents, as the prime cause of cracks and distortion of work is to be found in the operator's way of handling the piece to be hard-

ened. An illustration of what takes place when hardening may be given by referring to the die shown in Fig. 2. If we place the die in fire the points *C* will heat and expand quicker than the main body of the die and there must be a sort of a "pushing" effect between the points *C* and main body of die. For this reason we heat "slowly and evenly." Now, when we dip the die in the bath the points *C* immediately become chilled, and, of course, contract while the main body is still red hot. Assuming that the points have become entirely cooled, there must be a line that separates the part that has been cooled off from the red-hot part. It must follow that when the main body begins to contract there is a powerful strain at the line that separates the parts contracting at different times. For this reason the die should be removed when quite warm; this allows the heat to run out into the points and the contraction will be more even. If allowed to cool in the bath there is apt to be a crack at *D*. Polish the die to draw the temper, and do not depend on getting an even temper by drawing the die when it is dirty, as one part may draw faster than another.

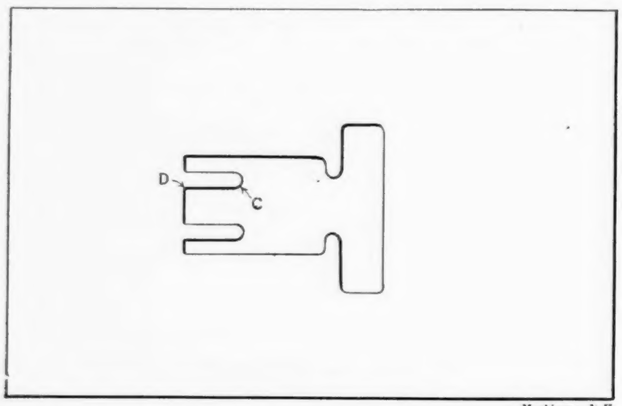


Fig. 2. Die of Irregular Shape subjected to Heavy Strains in Hardening.

Doweling Hardened Parts.

When making pieces such as sections of a built-up die, or any piece having dowel holes, it invariably happens that the dowel holes do not line up after hardening. One way to overcome this trouble is to tap the dowel holes a trifle larger than the dowels to be used, and after the piece is hardened, screw in soft plugs and file off flush with the work; when the piece is screwed in its proper place the dowel holes are drilled and reamed through the soft screw bushings. This will save a great deal of unsatisfactory lapping.

Simple Method for Cutting Cams Accurately.

Cams are generally laid out with dividers, machined and filed to the line. But for a cam that must advance a certain number of thousandths per revolution of spindle this divider method is not accurate. Cams are easily and accurately made in the following manner. For illustration, let us make the heart cam Fig. 3. The throw of this cam is 1.01 inch. Now, by setting the index on the miller to cut 200 teeth and also dividing 1.01 inch by 100 we find that we have 0.011 inch to recede from the cam center for each cut across the cam. Placing the cam securely on an arbor, and the latter between the centers of the milling machine and using a convex cutter, set the proper distance from the center of the arbor, we make the first cut across the cam. Then, by lowering the milling machine knee 0.011 inch and turning the index pin the proper number of holes on the index plate, we take the next cut and so on. Each cut should be marked on paper so that there will be no mistake as to number of cuts taken; when 100 cuts have been made the knee must be raised in order to complete the opposite side of the cam.

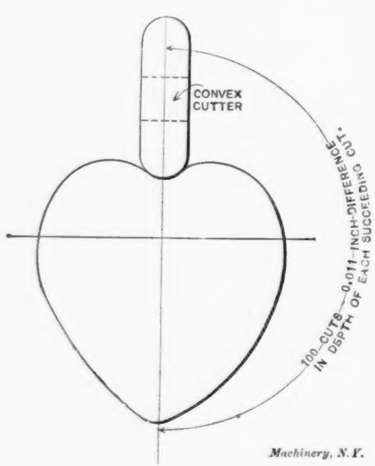


Fig. 3. Method of Cutting Cams.

Method of Locating Stock in Dies.

When a job will not warrant the expense of a sub-die the device shown in Fig. 4 will help wonderfully toward producing accurate punchings. To simplify the explanation, the die shown is to cut washers, the holes being eccentric with the outside. The die is laid out same as any double die, but the stop pin *G* is added, and as will be noted, the extension *K* does not come out of the die. If, however, one depends entirely on this stop pin, the result will not be satisfactory, because when the stock is pulled against the stop pin the web between the blanked places will bend a trifle, especially if the stock is thin. Therefore the long pins *H* are added, and as these long pilots or traveling dowels are well pointed, and are considerably longer than the punches, they of course enter the holes and force the stock back to its proper location. The pilots fit the holes in the die and they therefore act as dowels while the punch is cutting. The pilots and the spring butts *L* keep the stock pressed firmly against the gage side of the stripper, and the stock can vary 1-16 inch. With this construction the operator is enabled to keep the press running constantly to the end of the strip. At each stroke the punch *G* cuts out the web and allows the stock to slide along to the next web and there is absolutely no possibility of the stock jumping the stop.

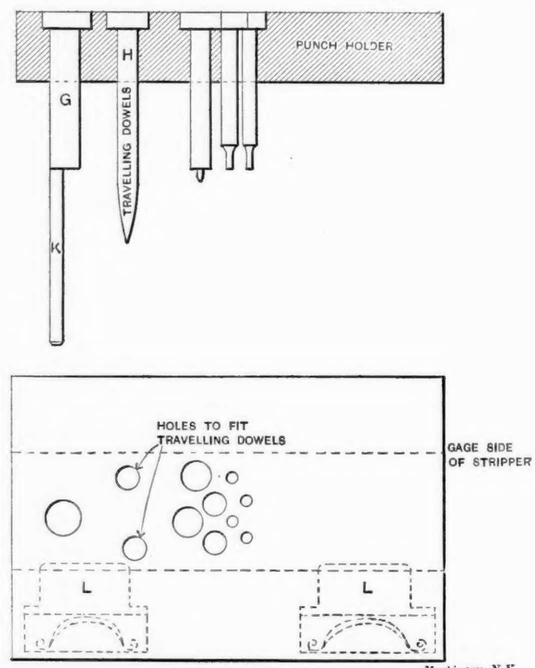


Fig. 4. Punch and Die with Guide Pins.

As washer or small wheel dies are generally made to cut four or more blanks at one stroke, the following method of transferring the holes to stripper and punch holder will be of benefit to some readers. If the punches are small it is advisable to make the stripper, say, ½ inch thick, and dowel it with four good-sized pins to the die. The holes through the stripper are bored to fit the punches nicely. This will act as a guide and prevents the punches from shearing. When the stripper is doweled to the die we lay out the former with buttons or by other methods governed by accuracy demanded and each hole in turn is indicated, and bored through the stripper and die. If the holes are so small that they will not readily admit boring to such length, the stripper may be bored and removed and the die then bored. The die must, of course, be fastened in such a manner that the stripper can be removed without loosening the die. If properly doweled the punch holder, stripper and die can be bored together, thus insuring perfect alignment of the punches and the die.

A Good Way to Make an Irregular-shaped Die.

Fig. 5 shows a time saver, as the die can be made easier and better because the parts can be ground to size instead of the die being filed out. Another advantage is that if the

pieces warp in hardening they can be ground into shape again. The pieces *M* are shrunk on the sections, holding them securely together. The holes *N* are drilled for clearance for the emery wheel when grinding to size. The straps *M* are made a trifle shorter than the die over all, say 1-16 inch to the foot, and are heated red hot in the middle and placed in position while hot and rapidly chilled. After the pieces are shrunk on, the dowels are transferred into the bolster.

Another good kink when making irregular-shaped punches that are to cut thin stock is to make them of machine steel and caseharden them. Soft steel, casehardened, does not change its form as much as tool steel, and even if the punch does change a trifle the interior is soft and can be readily forced back to position. The outside being hard, the punch will wear nearly as long as one made from tool steel, for practically the only wear on a punch is when passing through the stock. For thin brass the punch works well when made of tool steel and left soft, and when worn badly the punch can be peened on the face enough to upset and then sheared into

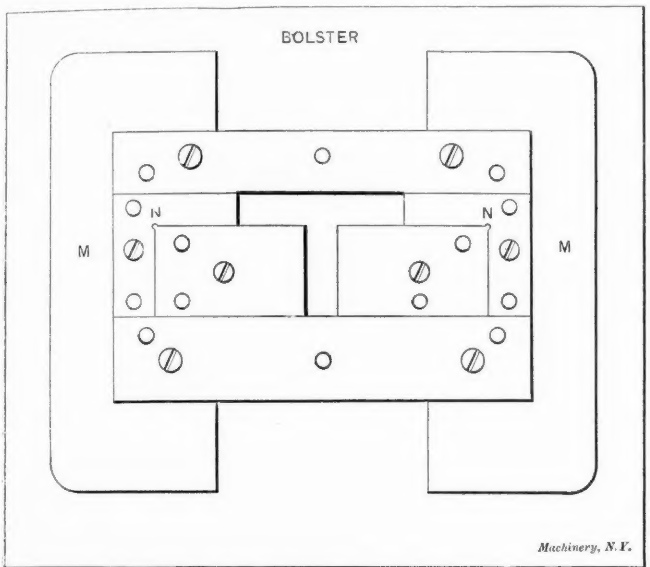


Fig. 5. Example of Built-up Die.

die. When cutting a heavy blank it is a good plan to grind the die so that the surface is quite rough as the high spots then cut a trifle ahead of the low points. This will cause the die to run longer between grindings and is also easier on the press, while with a die that is ground perfectly smooth the entire cutting surfaces of punch and die meet simultaneously and the entire cutting surface of punch and die are placed under a tremendous strain. By grinding the die slightly lower on each end, thus producing a shearing cut, the die will last longer.

* * *

There has of late been some experimenting in the machine tool line to introduce leather clutches in place of the tooth clutches which always are more or less objectionable on account of the noise which is practically inseparable from their use. In automobile design the leather clutches have also gained more or less prominence. For this reason it is of interest to note some rules given in the *Autocar* for treating clutch leather. The most difficult trouble with leather clutches is that the leather after a time becomes too smooth and hard, obtaining practically a polished surface. In such cases it is necessary to dismount the clutch and scrape the polished surface of the leather with a knife or a coarse file and then immerse the clutch in water of a temperature of 80 degrees F. until the leather is thoroughly saturated. To attain this will take about 24 hours. The leather should then be dressed with oil, liberally applied, and as the water dries out, the oil will soak in and replace it. This will prevent the surface of the leather from getting hard, and showing a polished appearance, which, of course, is greatly detrimental to the power transmission qualities of the clutch.

* * *

If one-half of six be one-eighth of three what would one-third of a quarter be?

THE APPRENTICE AND HIS BEST GIRL.

E. R. PLAISTED.

Much has been written of late on the apprentice question, and as to why so many boys fight shy of the machine shop, and so many young men leave it for other occupations. Among the reasons for this the influence of wives and sweethearts has been mentioned as not being the least effective. There is no denying that the men and women we come in contact with have much influence over us and much effect upon our lives, no matter how independent of thought and action we may be. In the case of a young fellow just deciding on his course in life this is especially true, and if there is anything about the machinist trade that works against him in his standing in society, or with his wife or sweetheart, it should be remedied if possible.

"It is not good for man to be alone," and while that society which can only be adequately spelled with a very big S is not likely to enter much into the problems of a man who must earn his living at any trade, or whose purposes in life are vital and actual, the companionship of educated and cultured people is a thing to be prized and sought by anyone. It is not enough to have merely avoided bad company, for the man who shuts himself up in his shell too closely never reaches the best he is capable of, no matter how absorbing and engrossing his work may be.

The old saw about all work and no play applies to us at all ages and in all walks of life. Under normal conditions and circumstances there are very few times in our lives when we cannot to advantage indulge occasionally in play of some sort, and then we are pretty sure to crave the companionship and society of our fellows. Even the lower animals congregate together for sport and frolic.

Conditions which are the growth of recent years and which have changed and modified our whole social structure have, naturally, had their effect on the social standing of the workingman, but I do not believe the time has come yet, or that it is likely to, when a man will fail to win deserved recognition from those whose companionship will be valuable to him, just because he is a "dirty machinist."

I wish those boys who take up with counterjumping and other poorly paid but "genteel" occupations could realize that a machinist is not necessarily dirty, even while at work, and that a really good workman—no matter what his trade, usually takes some pride in himself as well as in his work. I know a case of two machinists that well illustrates how much depends on the man and how little on his occupation in such matters. Nearly all the conditions under which they work are practically equal, and both are men of skill and experience. One of them gets just about as many dirty jobs, real soft squashy snaps, as the other, but while one wears a neat tie and linen collar and keeps them presentable the week through, and in general has a clean appearance, the other has such a faculty for attracting to himself the dirt and grime that often by ten o'clock of a Monday morning it might well puzzle a stranger to tell whether he is of African or Aryan ancestry. The machinery business is not to blame for such a state of affairs.

Of course there is considerable difference in shops as to the standards of cleanliness and the encouragement offered a fellow to keep himself respectable in appearance and habits, but shops are not common where a premium is put upon vileness of language or person, or where a young fellow who tries to keep himself wholesome will be persecuted therefor. I did once know a foreman who said no man could work for him and wear a boiled shirt in the shop, but the kind of boys I'm talking about wouldn't work for that sort of a man long, anyhow if they knew it. If you find yourself in a shop where these influences are not only neutral but actually negative, better get out; it is no place to grow and get ahead.

I doubt if there is now much cause to complain about the average shop in this respect, though there is probably plenty of chance for improvement; for while the foreman may have done all we can reasonably require of him when he provides well swept floors, well washed windows, and decently clean and sanitary toilet accommodations, still no one can do so much as he to establish a sort of cleanly atmosphere in which a dirty man will feel himself out of place. It is claimed now-

a-days that health is contagious as well as disease. Isn't it quite as likely that cleanliness may become "catching" in a favorable environment?

It may be true that the apprentice sometimes finds his best girl sitting in the hammock with the bank clerk or the dry-goods clerk whose hands are nice and white and whose tailor-made clothes take the bulk of his income; and it may be true that the influence of wives and sweethearts has caused good men to give up the shop for some more cleanly place. All this may be true, but I have enough faith in both wives and sweethearts to believe that, to the majority of them, the man who attracts and holds their respect and affection is the man who *does things*, things worth the doing, and who does them well.

The girl who throws over the machinist or the apprentice for a clerk probably made mud pies when she was younger, and enjoyed it fully as much as did the girl the machinist finally does marry. There is a time in the life of most normal boys when they have a mighty dread of soap and water in combination, though they know the water is all right to go swimming in, and the soap a most excellent thing to secrete inside the apple the other fellow brought for his luncheon. But your girl grows out of mud-pie pleasures, and your boy—if home influences are what they should be—usually gets over his fear of soap and water fully as soon as he gets over being afraid of the girls.

We all love the girls who are sweet and neat, it is the natural and rightful heritage of maidenhood, but the girl who is merely "finicky" and declines to sit in the same hammock with a promising young machinist just because there is a little honest dirt ground into his palms too deeply for soap to remove, that girl is not necessarily wholesome at heart and will very likely make anything but a helpful wife for either the machinist or the clerk.

Entropy says his neighbors across the way may think what they please and he will not budge a hair, but admits he values the opinion of some other "neighbors" whose very place of residence is unknown to him. Most of us come to this view sooner or later, but we can't quite expect it of the young apprentice. The girl across the street is a heap more real and interesting to him than the shadowy image we call the average girl. It is the particular girl he is interested in, not the average girl, and he will fight shy of the shop if he thinks working there will place him at a disadvantage in her eyes and favor.

I admit it is puzzling to me why society should draw the line at some kinds of dirt and disorder and yet put up with others far more disagreeable and annoying. For instance: why should the ban be put upon a little innocuous cast-iron dust and smiling toleration be accorded a breath that would stop an automobile, or a voice that would file a saw? These last abominations are not uncommon, even in the big S society. Perhaps it is for the same reason that two standards of morality have been set up, one for men and the other for women, if anybody can tell what that reason may be. Anyhow it is beyond me, but the men and women whose companionship is a thing to be prized and sought and deserved do not often make either of these glaringly inconsistent and unjust discriminations.

We are all looking for things that "pay," and it pays big to have the advantages given by a wholesome and attractive personality; to be physically clean inside and out. The dirty hands yield to soap and water and energy, and the foul breath generally succumbs to physic and water and determination. None of these have yet been cornered by the clerks, and when the young machinist has made liberal use of them, the people he ought to know, will, if he gives them a fair chance, find him out and take him for all he is honestly worth. If he has the qualities that appeal to men and women of the better sort they will hardly hold him at arm's length because of his occupation.

The root of some of these troubles lies in a trait that is said to be growing national with us, our lazy way of submitting to petty injustice, petty annoyance, and petty insult rather than take the trouble to correct such abuses of our good nature. When it becomes necessary to post notices in public places to prevent spitting on the floors, and when a leading periodical of unquestioned standing dares to print a full page editorial on the lack of common politeness and even common decency among the public servants of our greatest American city, what may we not expect? We have to pay twice for a good many things we have, and sometimes the second fee is bigger than the actual market price of the goods. Probably the time will never come when the machinist must give tips to get his rightful share of waste and oil and files, but would it be one whit more outrageous than some other cases of tipping that are of everyday occurrence?

The mud won't clear from the water as long as the current is swift, but it settles of its own accord when the stream flows deep and tranquilly. As long as we are living so fast that we haven't time to get acquainted with our own children, how can we be expected to cultivate the "amenities" of life unless induced to do so by liberal tips or fear of prosecution? It "wouldn't pay?" Well, perhaps not.

Society of all kinds requires a certain thickness of veneer over the rough outlines of the untamed human animal, but the kind that will be of value to the young fellow with a real purpose in life is very quick to detect the quality of stock hidden under the varnished covering. And I'm confident there is just as much good oak and rock maple in our human furniture to-day as there was before we cut off such an alarming amount of our primeval forest. Sometimes we hear an elderly man spoken of as a gentleman of the old school, as if that school no longer had any primary classes. And it is not so long since some musicians feared that with the death of Adelina Patti the old Italian method of singing would fade into the limbo of lost arts. But Melba and Sembrich appeared, and others are coming. Generations yet unborn will have their "gentlemen of the old school" and who shall say that none of these may be machinists?

* * *

The recent automobile show held in Madison Square Garden, January 12 to 19 inclusive, under the auspices of the Association of Licensed Automobile Manufacturers was a great success in point of attendance and the number of machines sold. Notwithstanding the fact that on Tuesday and Thursday of the exhibition week the admission was raised from 50 cents to $1.00, the total number of visitors is said to have been upward of 124,000. The reason for the increased admission price was to reduce the crowd to include so far as possible only those who were interested in machines to the extent of being possible buyers. Next year it is proposed to increase the admission price for two certain days to $5.00. But why not go one better and put every visitor on these days through a cross-examination as to his intention, financial standing, etc. In that way, the undesirable (?) crowd could be reduced to a mere handful which would waste little of the valuable time of the haughty automobile magnates. As a matter of fact, however, what the automobile manufacturers want is the fullest possible publicity. The more people know about their machines whether they are at present able to buy or not, the more possibility there is of selling machines in future. It is part of every manufacturer's business to manufacture a market as well as to supply the demand. The excuse given for the proposed exorbitant admission price is probably a subterfuge to cover a scheme by which some would seek to gain a large profit. We believe that the manufacturers will do well not to countenance such a scheme.

* * *

Next to "high polish and deep scratches" a highly polished but uneven surface is to be avoided. Nothing is more common, however, than to see metallic surfaces, especially brass signs and similar pieces, highly finished but wavy or irregular in contour, as can be easily detected when the light is reflected at a more or less acute angle. The effect is displeasing to the eye and largely offsets the value of the high finish. A highly finished metallic surface should first be made truly flat or cylindrical (as the case may require) by machining or grinding. Polish will then give a rich effect similar to that of plate or cut glass. Of course it is not practicable to do this in many cases, but where an extremely fine effect is required it should invariably be done.

ROUGHING AND FINISHING SPRING SCREW DIES.

ERIK OBERG.

In order to obtain uniform and well-finished threads when cut with spring-screw threading dies it is well known that it is necessary to use two dies, one for roughing and one for finishing the thread. In general practice the roughing die is obtained simply by adjusting a regular spring screw die of standard size to cut a certain amount oversize. This, of course, answers the purpose well enough for most classes of work for which this kind of die is used. It is evident, however, that there is no great certainty as to the relative amount of metal removed by each die, and it is most probable that the roughing die at least on larger sizes is doing far more than its fair portion of the work, leaving but a small amount of metal for the finishing die to remove. The latter die should, of course, not perform as heavy a duty as the former, but it is considered as a fair proportion to let the roughing die remove two-thirds and the finishing die one-third of the total amount of metal to be removed. In order to obtain such a proportion some firms who perform very close work by means of spring-screw dies make special roughing dies, enough oversize to permit the finishing die to cut the predetermined amount of the thread. These roughing dies are provided with perfectly-shaped threads, simply hobbed out with a tap which is the desired amount oversize as well on the top as in the angle of the thread. In this manner the finishing die will remove a certain amount of metal both on the top and in the angle, thus finishing the whole thread perfectly smooth and to the correct form.

It must, of course, be determined how much oversize the roughing die is required in order to leave one-third of the metal to be removed by the finishing die. This can be expressed in a simple formula with the pitch of the thread as the variable. In Fig. 1 the relative amounts of metal removed by the respective dies are shown in a diagram; we have here a United States standard thread where the amount of metal represented by the area *ABDC* is to be removed by the roughing die and the area *BEFGHACD* by the finishing die. The derivation of the formula we wish to obtain is as follows:

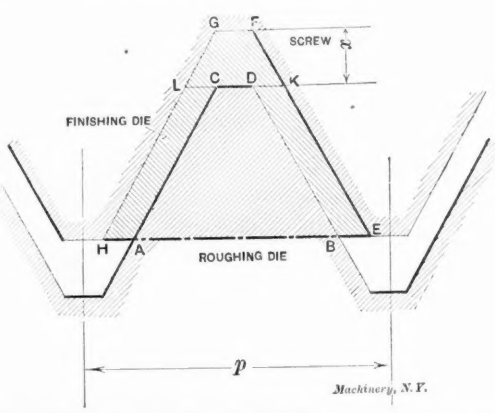


Fig. 1. Diagram of Metal Removed, United States Standard Thread.

The area of a section of a full V-thread with the pitch p is $\frac{1}{2}p^2 \times \cos 30$ deg. Subtracting from this the amounts

$$\frac{1}{2} \times \frac{1}{64} p^2 \times \cos 30^\circ, \text{ and } \frac{1}{2} \times \frac{1}{64} p^2 + \cos 30^\circ + \frac{7}{64} p^2 \times \cos 30^\circ,$$

which represent the areas deducted from a full V-thread in order to obtain the area of a section of a United States standard thread, we find this latter area to be $\frac{3}{8} p^2 \times \cos 30$ deg.

Consequently the amount of this sectional area to be removed by the roughing die is $\frac{1}{4} p^2 \times \cos 30$ deg. and the amount to be removed by the finishing die $\frac{1}{8} p^2 \times \cos 30$ deg.

Referring to Fig. 1 we therefore arrive at the following equation:

$$\frac{1}{2}\left(\frac{7}{8}p - 2x \times \tan 30^\circ\right)^2 \cos 30^\circ - \frac{1}{2} \times \frac{1}{64} p^2 \times \cos 30^\circ = \frac{1}{4} p^2 \times \cos 30^\circ.$$

Solving this equation gives $x = 0.135\ p$ approximately. The diameter of the tap with which the roughing spring-screw die is to be produced should thus equal the standard diameter plus two times 0.135 p. This refers to United States standard threads.

For the same proportions between the amount of metal removed by each die, if a full V-thread is to be cut, the formulas are, of course, derived in the same manner, but have

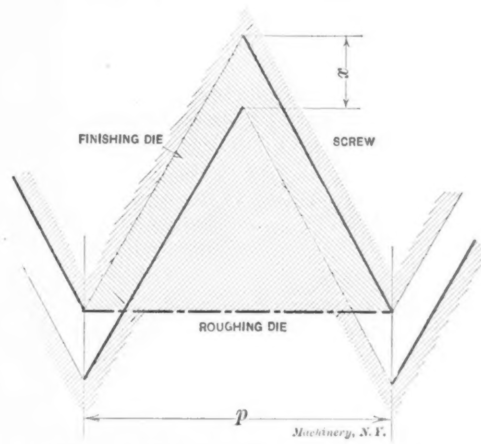


Fig. 2. Diagram of Metal Removed, Standard Sharp V Thread.

a different aspect. The area of a section of the thread is $\frac{1}{2} p^2 \times \cos 30$ deg. The amount of sectional area to be removed by the roughing die is consequently $\frac{1}{3} p^2 \times \cos 30$ deg.

Referring to Fig. 2 we arrive at the following equation:

$$\frac{1}{2}\left(p - 2x \times \tan 30^\circ\right)^2 \cos 30^\circ = \frac{1}{3} p^2 \times \cos 30^\circ.$$

Solving this equation gives $x = 0.160$ approximately. Using this value the diameter of the roughing die is now easily determined.

If we wish to give formulas for the results obtained, we can express them in the following manner:

For the United States standard thread, $R = D + 0.27\ p$.

For sharp V-thread, $R = D + 0.32\ p$, in which formulas

R = diameter of roughing die,

D = standard diameter of finishing die, and

$$p = \text{pitch} = \frac{1}{\text{number of threads per inch.}}$$

It is, of course, of no great importance if the amount removed by each die is somewhat different from the values given, the amounts to be removed being arrived at in a purely arbitrary way from the beginning. But the proportions given conform to the practice of a prominent tool manufacturing firm, and the calculations are given to show that even in a territory largely given over to "guess work" there can be exact calculations made and adhered to. In toolmaking, as a rule, calculations form a very small part, and altogether too often is "a few thousandths over" or "a few thousandths under" considered the only way to determine certain values which, if once settled upon, could be formulated by simple figuring so as to serve as a permanent guide for the toolmaker. It is a mistake to think that toolmaking is so widely different in its nature from other fields of industrial progress that here no strict rules can be followed. It must be admitted that there is perhaps no field of mechanical achievement where opinions differ so widely as they do in regard to toolmaking. But that is no reason for continuing to consider toolmaking as a territory where no principles or rules can be concentrated in simple formulas, arrived at in a logical and common-sense manner.

STRUCTURAL FEATURES OF THE EDGWICK WORKS OF ALFRED HERBERT, LTD.

The new works of Alfred Herbert, Ltd., Coventry, England, are located at Edgwick, a little more than two miles removed from the head works, and adjoining their foundry. It is intended to carry on the Edgwick works as an entirely independent factory for manufacturing and finishing machine tools throughout. The new works will not be dependent upon the head works except in the provision of designs and in the manufacture of small tools, jigs and such special appliances. The principal works being at present fully equipped in these departments and having sufficient capacity to deal with the design of the machines and with the small equipment of both factories, it is, of course, best to utilize the same engineering department for the two plants.

The accompanying halftone shows the new building with the steel work erected, but not closed in, and will serve to give an idea of the general plan of construction and some of the interesting features thereof. The cut shows seven bays erected, but the plan includes eight bays in all, the eighth not having been erected at the time the photograph was taken. The width of the shop is 240 feet, each of the eight bays being 30 feet wide; the length of each bay is 100 feet, thus giving a shop floor area of 100 x 240 feet.

The plans provide for an extension to 240 x 400 feet all under one roof. The ends of the bays shown in the picture are covered by a screen, the framing of which is indicated in some of the bays; it is arranged that when the shop is extended the screen can simply be moved so as to form the end of the extension. All that will be necessary in making the extension will be to order from the mills the required number of additional columns, roof girders, etc., the work being interchangeable. The permanent end and side walls of the building are of brick.

In the design of the building, the intention has been that the roof shall be a roof pure and simple, that is, a covering with sufficient strength to support its own weight and to resist wind pressure, and of correct design to keep out the weather, but not to carry any additional weight or in any way to form any essential link in the framing of the structure. The stanchions or columns, which are of as simple design as possible, so as to avoid unnecessary cost, are carried on large footings imbedded in heavy concrete blocks, and are calculated to stand entirely by themselves without any assistance from the roof. The side members of each column carry the longitudinal crane girders in direct compression, no brackets being used. The central member of each column is prolonged upwards to carry the roof. It is calculated that the longitudinal girders placed on each column, together with the longitudinal gutter beams, stiffen the building so as to take all racking action away from the roof; this is still further provided for by the diagonal bracing, some of which can be seen at the extreme right and left ends of the cut. The roof is covered with corrugated sheets on the southern side and the northern side is entirely of glass. The southern side is lined with "uralite" sheets, the whiteness of which improves the light; it also diminishes sweating or condensation of moisture in cold weather.

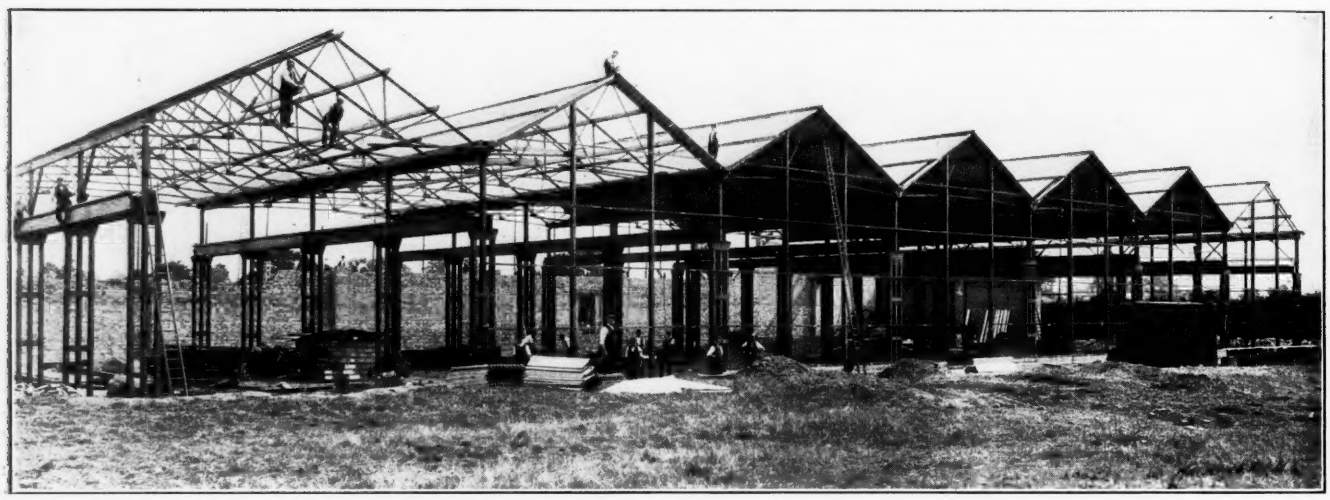
The longitudinal girders which carry the crane rails are installed in every bay whether it be a crane bay or a machine bay; in bays where cranes are used the ordinary rails are fitted to the top of these girders, but in cases where no cranes are required and where overhead shafts and countershafts have to be erected these longitudinal girders serve as supports for cross girders to carry shafting and countershafting. It is thus possible, should the condition require the rearrangement of the shop in future, to put cranes up in any machine bay, or on the other hand to install machines in any crane bay without altering the framing of the building in any way.

The floor is composed of 8 inches of concrete in which are bedded nailing strips 2 feet apart. The floor boards are of 2-inch creosoted timber, nailed down to the strips bedded in the concrete. Although the greater part of the floor is of wood, certain portions have been heavily concreted and are finished with blue bricks laid in cement. These sections are for the purpose of testing, running, and erecting heavy machines as it has been found that the elasticity of floor boards militate against the accuracy of erecting heavy machines. The head room under the girders is 14 feet 6 inches and 21 feet to the gutters.

The stores or control department will run across the ends of the bays extending the whole width of the shop and will have an area of 240 x 20 feet; there will be two tramways extending the width of the shop with turntables in each machine bay, and longitudinal rails will be laid in each machine bay between the rows of machines. The tramway in each bay can run straight into the storeroom so that material can be delivered to and from machines in a very direct manner.

All shafting will be driven by motors with a separate motor to each lineshaft, and all bearings will be self-oiling. Individual motors will only be used for heavy machines. The lineshaft, of course, is laid out longitudinally in each bay and each bay thus becomes a separate unit so far as power requirements are concerned.

As the present building is only one-fourth of its destined ultimate size, a permanent power plant has not been ordered, and provision has been made in building both the boiler house and the engine room to extend each to four times the present capacity without disturbing the present arrangements of the boilers or machinery. In order to avoid excessive idle expenditure in the beginning, it has been decided to have a stack at each end of the main flue from the boilers. The stacks being identical and each one serving for half the total installation, it is therefore only necessary to build one stack at present, thus saving idle capital that will be involved in a large stack of sufficient size for ultimate installation. The boilers are Babcock & Wilcox with Green economizers. The engine is a 300 horsepower cross-compound Corliss type engine built by Robey & Co., of Lincoln. It is fitted with independent surface condensers and is direct connected to a multiple generator of 220 volts.



Structural Features of the New Edgwick Works of Alfred Herbert, Ltd., Coventry, England.

A VERTICAL MILLER AND A TURRET LATHE OF ENGLISH DESIGN.

Our friends across the water, both in England and on the continent, derive considerable pleasure from their belief that the vertical milling machine has reached among them a higher state of development and attained a higher degree of appreciation than in this country. If this is so, there must be reasons for it; admitting for the moment that their contention is true, we might venture one or two explanations for this hypothetical condition. In the first place America was the birthplace and early home of the horizontal milling machine in its practical points. Its characteristics and capabilities are well known and appreciated by every Yankee mechanic worthy of the name. When the milling of a piece of work is in question, the natural tendency of the mechanic is to do it on some kind of a horizontal milling machine, if it can be done there without obvious unhandiness. If the piece seems awkward to work in this way, he will, as an alternative, consider the adaptability of the vertical machine for the work; in other words, the burden of the proof lies with the vertical machine. Besides, of these two tools, the horizontal type is essentially adapted for manufacturing, while the forte of its competitor seems to be rather that of jobbing, or, at least, working on comparatively small lots. Formed cutters, elaborate gang cutters, and expensive holding fixtures are the natural accompaniments of the horizontal spindle. Face mills and end mills, with a sparing use of cylindrical cutting surfaces, characterize the vertical milling machine. These two conditions then—a predisposition for the familiar and the American fondness for work which can be handled in large lots—will account for the somewhat higher development of the vertical milling idea in Europe than here; although perhaps we would not be willing to admit the use of the words "higher development" as meaning much more than that a greater number of firms are there engaged in building these machines, and a wider variety of types is there met with.

An Example of English Vertical Miller Design.

The accompanying cuts will be instructive as an illustration of one of the lines of development which the tool under discussion has taken in Great Britain. They illustrate what Alfred Herbert, Ltd., of Coventry, England, designates as the "No. 8 patent vertical milling and profiling machine." Unlike the design common in this country and followed by the builder in small sizes, this size has no vertical adjustment for the work. The frame has all the characteristics of that of the slotting machine. In fact, if the spindle were replaced by a ram, and the geared feed changed to a ratchet feed mechanism, the machine would be transformed into a slotter with all its appropriate slides and holding devices.

One of the first things that will be noticed is the fact that there is no gearing in sight in either of Figs. 1 or 2, which show the right and left-hand sides respectively of the machine. This habit of covering mechanism is indigenous to England, and is shown especially in the design of their locomotives with the inside cylinders and concealed valve gear. With the machine in question, however, the increasing strictness of the factory inspection requirements had as much as anything to do with the matter, and the builder thought it best to meet all possible requirements by encasing every gear used on the machine.

The feed is driven by a separate belt from the countershaft, an arrangement which has an effect corresponding to that obtained with the gear driven milling machines of this country, in which the feed motion is obtained from a single speed pulley. With either of these arrangements all the feeds (stated in terms of distance traversed per minute) are available with any spindle speed; thus the coarsest feeds can be used with very large cutters running slowly, and the finest feeds may be obtained with small and delicate cutters running at high speed—two conditions unobtainable with the usual construction. The horizontal millers of the same builder are arranged to be driven either from the spindle or from the countershaft, as may be desired by the purchaser.

A "dial" feed mechanism is employed, which is contained in the casing shown in Fig. 1 at the foot of the column of the machine. A handwheel is provided with an attached dial which is graduated for sixteen different positions. To obtain any one of sixteen feeds it is only necessary to move the handwheel until the dial shows the proper reading, no other movements being required. These feeds are arranged in geometrical progression, and by suitable levers and clutches may be applied either to feeding the saddle toward or away from the column, feeding the platen to the left or right, or rotating the circular table in either direction. Automatic and dead stops are provided for all these different motions.

The main table is very heavy and is provided with suitable channels for taking care of the lubricant used on the cutter. A covered way, which is thus protected from being clogged by chips, leads the oil from either end to the outlet pipe.

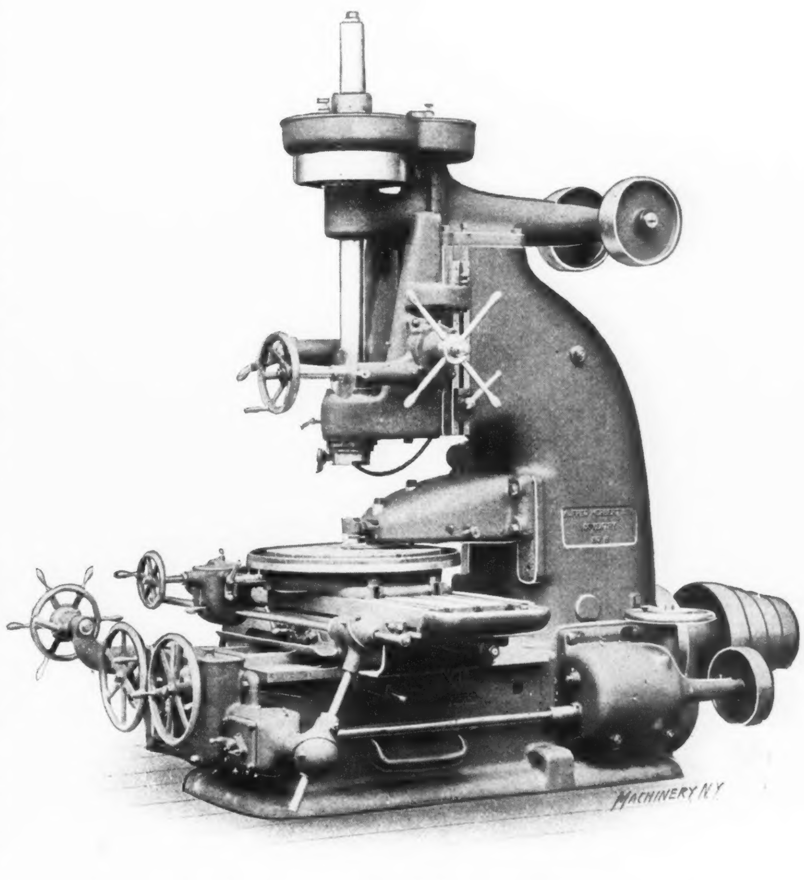


Fig. 1. Vertical Miller built by Alfred Herbert, Ltd., of Coventry, England.

The builders make a point of the great rigidity of the table, which prevents distortion under the strain due to clamping the work. The sliding surfaces both for the round and longitudinal tables and the saddle have self-oiling provisions, and the reservoirs for these can be reached from the sides of the table without disturbing the work that may be clamped on it. All slides are fitted with clamping devices.

The spindle has 16 speeds in geometrical progression. It is of crucible steel, journaled in phosphor bronze boxes, which are provided with independent adjustment for diameter and end play. The belt pulley which drives the spindle is carried by a sleeve in the customary manner to prevent carrying the belt pull to the spindle bearing. The sliding head is counterbalanced and has both a fast and slow hand adjustment; the handwheel and clamping lever are brought well to the front so as to be easily accessible.

Description of the Profiling Attachment.

The machine shown in Figs. 1 and 2 is provided with a profiling attachment, which will be better understood by re-

ferring to Fig. 3, which illustrates the way in which the device is used. A heavy outboard support for the end of the cutter is provided. This support may be placed in either of two vertical positions, one of which is suitable for use with the circular table, while the other may be employed for working on the main platen. This support may be swung about a pivot on the left side of the machine so as to be out of the way when it is not in use. An eye-bolt, conveniently placed, furnishes a means of shifting it from its lower to its upper position, or *vice versa.* On the under side of this support, provision is made for attaching a roll to follow the former for profiling work. To adjust the depth of cut this roll may be shifted in or out independently of the guiding bushing for the cutter. In Fig. 3 a piece of irregular contour is shown mounted on the circular table in conjunction with a former, which is the lower of the two parts. The main platen is fed longitudinally, and the former is kept in contact with the roll by the action of a weight and its connected mechanism, shown near the base of the column at the left in Fig. 3; arrangements are made for permitting this weight to act independently of the cross-feed screw. The pilot wheel and attached pinion meshing with rack teeth cut in the radius rod running to the weight lever furnish means, when so desired, for withdrawing the former from contact with the roll and the work from contact with the cutter.

Taken altogether, so far as one can judge from the photographs provided, this machine and the members of its family, both horizontal and vertical, give evidence of careful attention to the details of design, and indicate a high state of development in the art of using the class of tools to which they belong.

A Hexagon Head Turret Lathe.

It will perhaps be interesting to compare a turret lathe by the same maker with American machines of its class. Fig. 4 shows the No. 2 patent hexagon turret lathe built by Alfred Herbert, Ltd. It will be noticed that the single speed pulley gear-driven type of headstock is used, with which 16 variations are obtained in the machine shown. The merits of this arrangement are so well known as not to require discussion. The same "dial" feed used in the vertical miller just described is applied to this machine as well, the handwheel and dial for operating it being shown just beneath the clutch levers on the headstock.

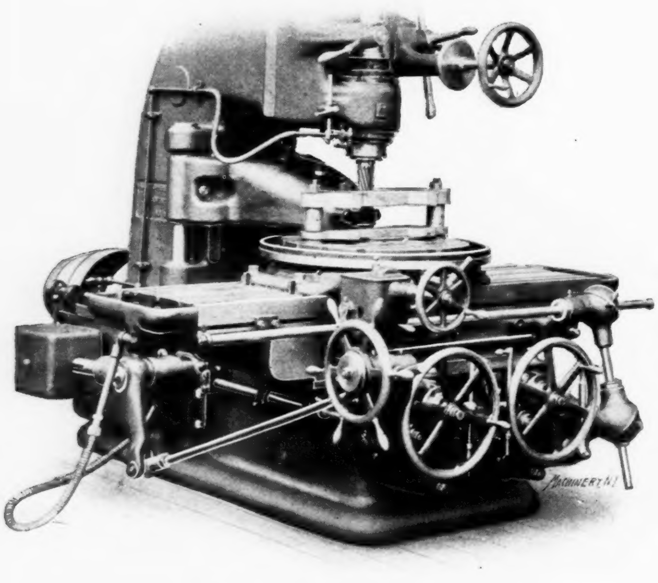


Fig. 3. Profiling Attachment in Use.

The long lever at the right of the headstock operates the chuck and stock feed mechanisms. The chuck is said to be especially effective and may be opened and closed while the lathe is running. Round jaws are supplied for round bars, giving more gripping power than is obtained with flat jaws; it is also claimed that the flat jaws do not allow work to be truly held by a finished surface for a second operation. Each jaw is in four sections, but it is recommended that only three of them be used when holding stock that is somewhat out of round. For holding square and hexagon bars flat jaws are provided.

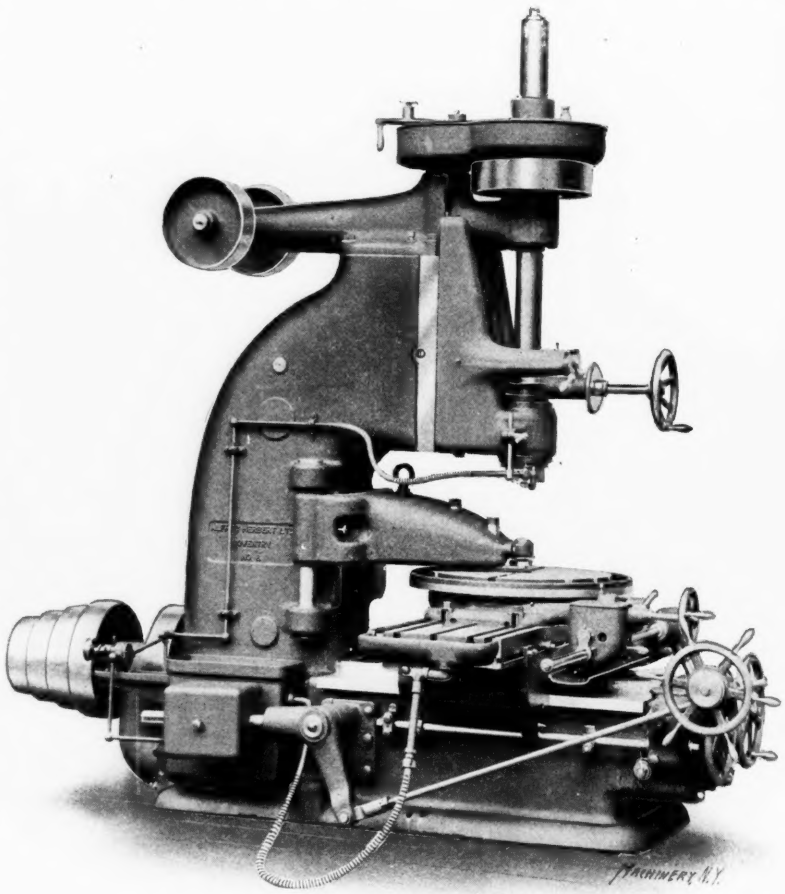


Fig. 2. Left-hand Side of Miller

The turret, as is indicated by the name of the machine, is of the hexagon type and is mounted on an unusually long slide, which is designed to pass beneath the end of the spindle when working with the tools close to the face of the chuck. This gives a good support for heavy cuts. The automatic stops are twelve in number, two for each position of the turret. They are clamped in the slots in the hexagon bar extending along the front of the bed, which bar is geared to rotate with the turret. The two stops are adapted to trip in succession on the forward movement, or one may be used for a forward stop and the other for a backward one, or both may be used for the reverse feed. A positive abutment, as well as an automatic trip, is provided by these adjustable stops. A large disk carrying three adjustable dogs on its periphery will be noted attached to the hub of the pilot wheel. Each of these dogs carries graduations which may be brought in line with a stationary pointer; this combination enables accurate lengths to be obtained within very fine limits of error. Besides this, for roughly gaging the length of cut, a scale is attached to the bed at the rear of the slide, which carries an adjustable pointer. This pointer may be set to an even foot dimension at the beginning of a cut, whose length may thus be read without directly measuring it on the revolving work.

Description of the Tools Employed.

Some idea of the tools employed may be gained from Fig. 4; four of the six ordinarily used are visible. Commencing at the left the first two are regular turning tools, the holders for

which are so arranged that cutters of a style familiar to the ordinary lathe hand are used. The cutter holder is a solid block of steel and is adjustable for diameter by a knurled knob, with the same facility that a slide rest is. When the cutter is once set for the correct height, no change is required for work of any diameter. The movement of the cutter is controlled by an adjustable stop which permits it to be withdrawn after finishing a piece of work, so as not to injure it when running the turret back; this stop is located in line with the screw which controls the movements of the cutter holder, so there is no springing of the structure. Steady rests are provided to support the work and act as burnishers, giving a smooth finish even when a heavy reduction is being made. A perfect finish is obtained, for instance, when reducing a 2-inch bar to ½-inch diameter at one cut. A point claimed for the holder and cutter employed is that downward wear on the top of the bed does not affect the diameter of the work, as is the case with end cutting blades acting on the top of the revolving bar. For reverse turning, that is, cutting away from the chuck instead of toward it, the only change necessary is to substitute a left-hand cutter and reverse the automatic feed by the handle provided for that purpose. This is advisable in slender work of considerable length.

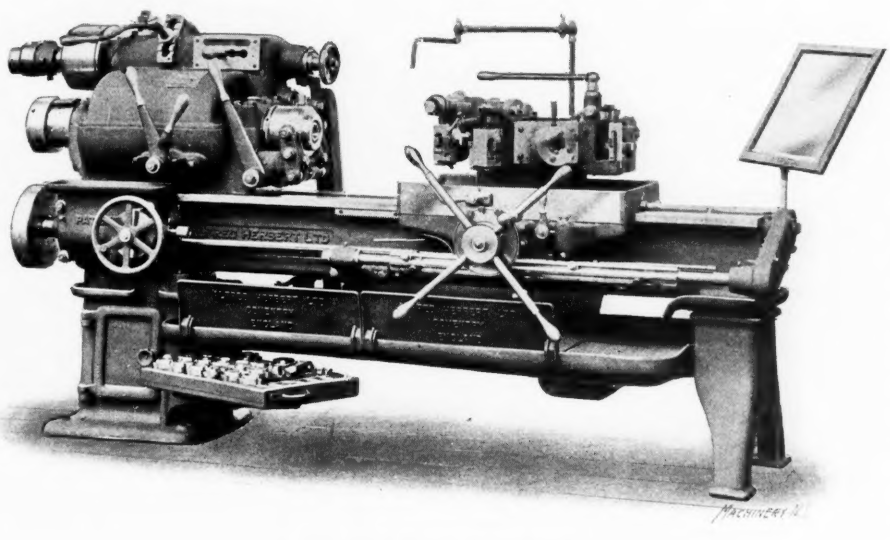


Fig. 4. Alfred Herbert Turret Lathe.

The opening die holder shown carries four chasers of the milled type, so arranged that the rear teeth act as burnishers and guiding surfaces for that part of the thread already cut, thus ensuring finely-finished threads and accurate pitches; it is provided with an arrangement which allows a roughing and a finishing adjustment, independent of the setting for size. The tool at the extreme right is a cross slide, carrying two toolposts, operated by a lever and pinion arrangement. One of the tools may be used for cutting off, the other being the forming tool. Besides these appliances, a triple holder (not in sight in the illustration) is employed. This carries three tools, an adjustable stop, a centering tool, and an end rounding tool—thus giving in effect two additional faces to the turret. A taper turning tool, not shown, is also provided for right and left-hand tapers of any angularity desired.

* * *

A remarkable bridge-building feat is reported from Canada, in connection with the St. Maurice Valley Railway, which has been built to connect the Shawinigan Falls and the Canadian Pacific Railway at Three Rivers. In order to win the large subsidies offered, it was necessary to complete the line—twenty-two miles long—by the last day of 1906. There were two heavy bridges to be built, and one, known as the Gorge Bridge, which was 135 feet high and 330 feet long, was not begun till December 15. With fifteen days to do the work in, the builders put on three shifts of men, and kept them going, with the result that the last rivet was driven in at 11:45 P. M. on December 31. The first train passed over the completed road before midnight.—*Page's Weekly.*

THE CONSTRUCTION OF SPLIT DIES FOR PRESS WORK.

C. F. EMERSON.

A die of great importance in the production of sheet metal parts is the split die. There are two principal reasons for using the split die. One is that it sometimes happens that the blanks to be cut are of such a shape that the die can be more quickly and cheaply made by making a split die than by making a solid or one-piece die. The other reason is that when the required blank must be of accurate dimensions, and there is a chance of the solid die warping out of shape in hardening, the split die is preferred because it can be much more easily ground or lapped to shape.

Fig. 1 shows the manner in which the ordinary split die is usually made. After the die is worked out it is hardened and ground on the top and bottom. The two sides *A* are then ground at right angles with the bottom.

The cutting parts of the die, *B*, are next ground at an angle of 1½ degrees with the bottom, so as to give the necessary clearance in order that the blanks may readily drop through. The key *D* is now set in place, and the die is keyed in the die bed by the aid of a taper key. The key *D* prevents the die from shifting endwise; the keyway should have rounded corners as shown, which not only give added strength, but also act as a preventative to cracking in hardening. The last operation is to grind the two circular holes. This is done by first lightly driving two pieces of brass or steel rod into the holes until they are flush with the face of the die. The exact centers are then laid out and spotted with a prick punch, care being taken so as to get the centers central with the sides *B*. The die is now fastened to the faceplate of a universal grinder, and the center mark is trued up with a test indicator until it runs exactly true. The brass rod piece is then driven out, and the hole ground to size, with 1½ degree taper for clearance. The other hole is next ground out in a similar manner which completes the operations in so far as the die is concerned. It often happens with a die of this kind that

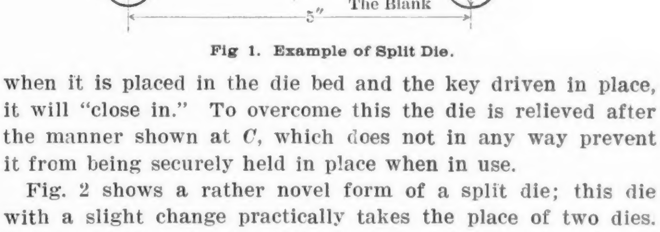


Fig 1. Example of Split Die.

when it is placed in the die bed and the key driven in place, it will "close in." To overcome this the die is relieved after the manner shown at *C*, which does not in any way prevent it from being securely held in place when in use.

Fig. 2 shows a rather novel form of a split die; this die with a slight change practically takes the place of two dies. It is used for piercing slots in brass plates. The size of the slot for one style of plate is 4⅜ inches long by ¼ inch wide; for the other plate the slot is 4 inches long by 5-16 inch wide. The cutting part of the die, shown in Fig. 2, is made in four sections, *A*, *B*, *C*, *D*. The cut fully explains itself and therefore needs no detailed explanation. It may not be out of place, however, to say that the soft steel bushings, as shown, are used to allow for the contortion of the parts *A* and

B in hardening. It may be added that the four bushings shown in the piece *A* were driven in first; then solid pieces were driven in the part *B*; then the holes were drilled in these latter pieces, being transferred from the bushings in the part *A*. In Fig. 2 are also shown the parts used in connection with this die for piercing the 4 x 5-16 inch slot. These parts are made as shown, and are hardened only at the cutting ends. Outside of the fact that this style of die practically takes the place of two dies, there is still another feature in connection with it that will bear mentioning; there is no special or extra die bed required for this die when in use.

It may not be amiss at this time to say a few words with reference to die beds. The writer prefers to use the name die bed, for the reason that he thinks it is the most appropriate name. In some shops, however, this part is called bolster, die block or die holder. Perhaps the most commonly used and the best die bed for general use in the press room is the style of bed shown in Fig. 4. A similar style of die bed was described by the writer in the January, 1905, issue of MACHINERY; the die bed then referred to, however, was used for holding cutting and drawing dies. The die bed, as shown in Fig. 4 is principally used for the reason that the screws that fasten the die bed to the bed of the press do not have to be screwed entirely out, either in placing the die bed in the press or in taking it out, as the slots *C* and *D* are made at right angles with each other for just this reason.

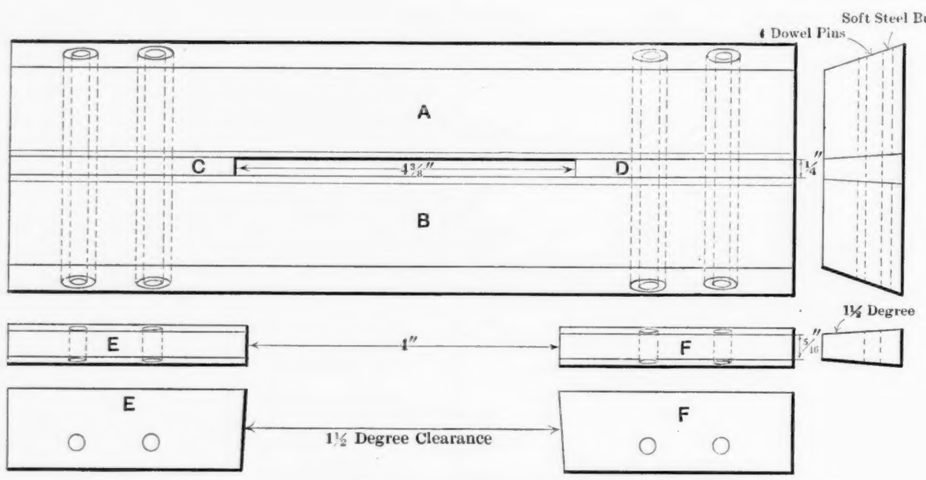


Fig. 2. Die with Interchangeable Parts, permitting Two Sizes of Blanks to be Punched by Changing the Center Pieces only.

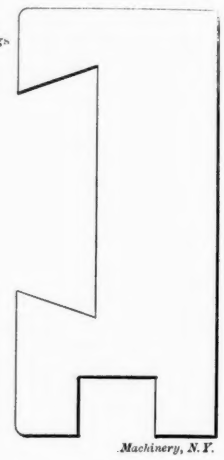


Fig. 3. Gage for Planing Die Blanks.

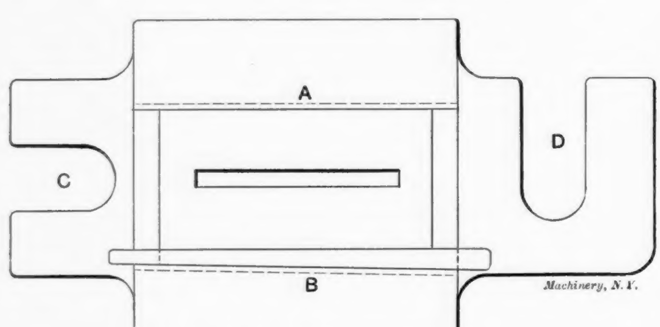


Fig. 4. Example of Die Bed.

The dovetail channel is planed so that when the die is keyed in position the center of the die is central with the slot *C*. The side of the die bed marked *A* is planed at an angle of 10 degrees, and is parallel with the slot *C*. The side marked *B* is planed at an angle of 13 degrees and is at an angle of 1 degree with the centerline. The reason for planing this side to an angle of 13 degrees instead of ten is that the increased angle causes the die to lie flat, and prevents it from raising or tilting up in any way when the key is driven in.

In speaking of the key the writer may add that from a mechanical and economical standpoint he has come to the conclusion that the taper-key method of holding blanking dies in the die bed is the best of the various methods he has come in contact with. The set screw method he considers the poorest of all. The key as shown in Fig. 4 is driven in on the front side of the die bed. This is optional, however, as the practice differs. In some shops the key is driven in on the front side while in others it is driven in on the back.

Of late years there has been a tendency among large concerns to have all their die beds for the power press made from semi-steel castings, or of machinery steel for certain classes of heavy work, instead of from gray iron as heretofore. This is being done because a gray iron die bed that is used day after day for holding dies for cutting heavy metal will not stand up during long and hard usage as it should. Past experience has proven that gray iron die beds in time become out of square; then, again, they sometimes crack. With the semi-steel, or the soft steel die bed, this does not happen. It has been found that semi-steel and machine steel die beds pay for themselves many times over.

In planing up the stock from which the blanking dies are sawed off before they are worked out, a gage similar to the one shown in Fig. 3 should be used for planing up the different widths of dies. In this way the dies will be of a uniform width and thickness, which makes it possible to have them interchangeable with the respective die beds for which they are used.

* * *

Nothing could be more suggestive of the method of transporting air than the word "fluid," which in its derivation means to flow. Wholesale transportation of a fluid is best accomplished, not by carrying, but as the very name indicates, by allowing it to flow always toward the point of least resistance. The transportation of fluids, of which air and water are the most familiar examples, results from the creation of a pressure difference between the delivery and receiving points. Ventilation, which as a process is the continuous removal of air from a closed space, is but the result of the natural or artificial creation of such conditions. When any considerable resistances have to be overcome, artificial means must be employed. The working of deep and extended mines has only been made possible by the provision of mechanical means in the form mof the fan blower by which air in adequate volumes can be furnished to the workers. The first crude application of a fire at the mine outlet for the purpose of heating the air and producing flow was long ago superseded by the fan designed to insure positive action.

* * *

A St. Paul dispatch says that the state of Minnesota expects to raise to $400,000,000 the taxable valuation of the Hill ore lands, in view of the basis on which the recent lease was made to the United States Steel Corporation. It is stipulated in the lease that the Hill interests are to pay all taxes. Heretofore, it is stated, the assessed valuation of the properties has been approximately $30,000,000.

A SHAPER MOTION MODEL—ANALYSIS OF THE MOVEMENT.

Considerable attention is given in technical schools to the study of kinematics, a science which deals with the way in which motion is modified by mechanism. Extensive use is made of models in studying this subject. We show in Fig. 1 an apparatus of this kind recently furnished by the Mark Flather Planer Co. of Nashua, N. H., to the engineering school of the University of Michigan. It consists essentially of a 15-inch shaper, their smallest size, with the table and feed

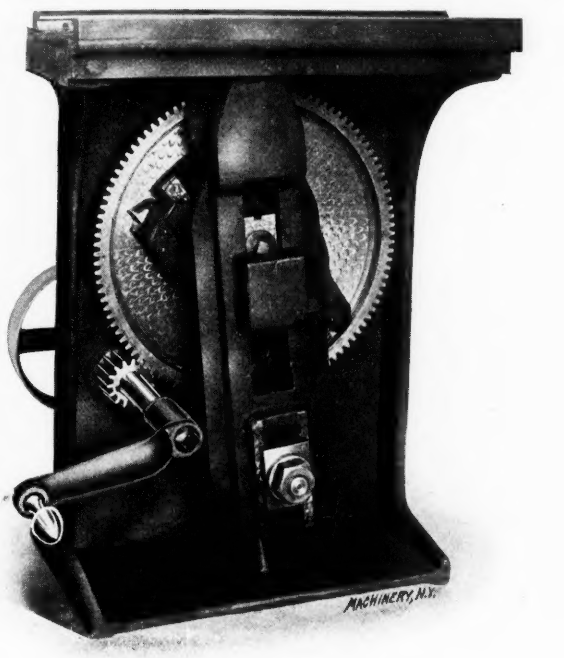


Fig. 1. Shaper Motion Model, built for an Engineering School.

mechanism removed, and with the ram driving parts mounted in a special frame, so as to leave one side open with all the parts exposed to view. Instead of having a ram, this machine is provided with a short slide only. The mechanism of the Flather shaper, which is thus displayed for the benefit of the students, is well known, and has been in use for many years. The line drawing, Fig. 3, and a brief description will serve to describe it so that its action will be understood. The arrangement shown in Figs. 1 and 3 has of course been modified somewhat in adapting it for use as a model, and the parts are not in all cases so strongly supported as they are with the double frame of the regular shaper column; the kinematic action, however, is identical.

Pinion *M* is driven by power or hand as may be required, either by the pulley shown or by the crank. This pinion meshes with the driving gear *L*, whose shank is journaled in a babbitted bearing in the side of the frame *B*, and is supported as well by a bearing on the outside of block *O*, which is bolted, in turn, to the frame. The driving gear has thus a double bearing. It carries a block, *P*, pivoted in a slot in the inner face of the crank slide *N*, whose axis is set eccentrically with that of driving gear. Gear *L*, block *P*, and slide *N*, form a modified Whitworth quick return movement of the kind commonly employed in slotting machines. The shank of the crank side *N* is journaled in a bearing in *O*, which enters a hole in the axis of the main driving gear and is bolted to the frame as before mentioned. For adjusting the stroke, crank *N* is provided with a slide, *F*, carrying the crankpin block, *E*. This slide may be adjusted toward or away from the axis of the crank by means of the scroll rack *H* attached to it, and the scroll *G*. As this scroll is rotated by the crank through shaft *J*, the rack *H* is moved out or in, and with it, the crankpin. Hand wheel *K* serves to lock the mechanism after the adjustment is made.

Crankpin block *E* slides in a slot in link *C*. This link is pivoted at the top to slide *A* as shown, and at the bottom has a forked end embracing the block on stationary pivot *D*. Adjustable crankpin *E*, link *C*, slide *A*, and pivot *D*, constitute a modified quick return movement of the kind usually provided for shapers, the only difference from the common type being the fact that link *C* is pivoted at the ram and slides longitudinally over the lower pivot *D*, while in the usual construction the link is pivoted at *D* and adjustably connected to the ram at the top. This change in the usual construction was originally undertaken to bring the sliding part of the mechanism to a position where it would have less wear than in the standard construction, but besides this, the change was found to have a good effect on the quick return function of the device, since it lengthens the upper end of the link and thus keeps up the cutting speed of the tool toward the end of the stroke at a time when the ram would naturally be slowing down.

For the sake of suggesting to draftsmen a method by which a motion of this kind may be analyzed and compared with other mechanisms to determine their relative value, we have here made a graphical determination of the velocity of the cutting tool at all points in the stroke. In doing this we had nothing to go by save an undimensioned assembled drawing, so that perhaps the results obtained may not tally strictly with actual conditions, but the results found are very good, and may be as easily obtained as poorer ones in this mechanism.

There are a number of ways of attacking the problem. We might, for instance, if we knew enough and had the patience, analyze the mechanism and deduce a formula giving the position of the shaper ram for any angular position of driving gear *L*, which is assumed to move at constant velocity. From this formula we might obtain by the differential calculus a second expression that would give us the velocity of the ram for any position of the driving gear. We will take, however, for illustration, a graphical process, being moved thereto by compassion for both writer and reader. Of the several ways in which the problem may be attacked graphically we have chosen what seems to be the simplest and quickest.

Fig. 2 presents a skeleton diagram of the mechanism. In laying it out, care should be taken to see that the dimensions

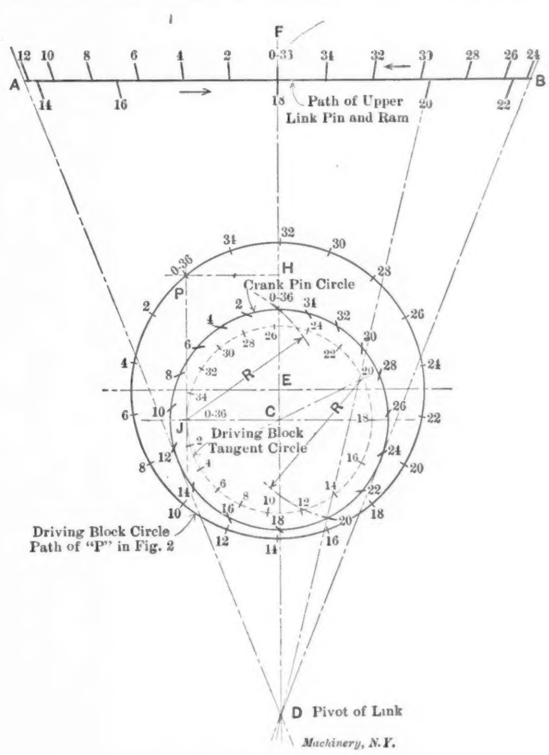


Fig. 2. Diagram showing Analysis of the Movement.

of the working drawings are carefully followed. *F D* is a vertical line drawn through the center of the driving gear and the link pivot *D*. *A B* is the path of the axis of the pivot at the upper end of the link. Draw the driving block circle with center *E*, the radius used being the distance from the axis to the center of the driving block pivot. In Fig. 3, the mechanism is shown at mid-stroke with the link vertical. In Fig. 2 determine the position of *P*, the pivot of the driving

block when in the position of Fig. 3, making $P\ H$ the same in each case. Starting at P divide the driving block circle into 36 equal parts, of which the even numbers only need be marked. It is now required to find out what angular advance will be given to the crank for each even advance of the driving block from station 0 to station 2; station 2 to station 4, etc.

Drop a vertical line from P and draw a horizontal line through C, the center of the crank. With C as the center, draw the driving block tangent circle, tangent at J to the vertical line through P. Through each of points 2, 4, 6, 8, etc., on the driving block circle, draw tangents to this tangent circle, and mark the points of tangency 2, 4, 6, 8, etc. Line $P\,J$ represents the direction of the slot in the crank which engages the driving block P, and a moment's consideration will show that on this account the points we have thus determined in the driving block tangent circle, will mark off the angular movements given to the crank for each even angular advance of the driving wheel.

It is now required to find the position of the crankpin for each position of the driving block P. With center C draw crankpin circle with radius equal to the distance of the crankpin from the axis of the crank at full stroke. When the driving block is at station 0, or point P, the crankpin is on the vertical axis of the mechanism at the station marked 0 in the diagram. To locate its other positions, with the dividers set for a distance R equal to the distance between station 0 at J on the driving block circle and station 0 on the crankpin circle, step off from point 2 on the driving block circle, point 2 on the crankpin side, point 4 from 4, point 6 from 6, and so on. This construction is shown only in the case of station 0 and station 20. The operator merely transfers the angular movements from their position on the smaller circle to their place in the larger circle without changing their value or arrangement.

We may now find the position of the ram for each station on the driving block circle. Draw a straight line through D, the center of the lower link pivot, and each station of the crankpin circle. The point where this line crosses $A\ B$, the path of the upper link pin, will determine the location of that link pin for each position of the driving gear. The construction is shown in the case of position No. 20. Tangents to the crankpin circle drawn through D determine, on line $A\ B$, the two extremes of the stroke. All this will be readily understood from a comparison of Figs. 2 and 3.

Our problem is now to draw a curve representing the velocity of the ram at any instant. If we are in a train, moving at a constant speed, and we have passed over 70 feet in the last second, we are evidently traveling at the rate of 70 feet per second, and that is the velocity of the train. If the train is traveling at a constantly increasing or constantly decreasing velocity, and we have traveled 70 feet in the last second, we may say with assurance that when half that second had elapsed, we were traveling at the rate of 70 feet per second. In the case of our mechanism in a similar way, (if we conclude that our stations 0, 2, 4, etc., are so close together that the acceleration or rate of change of velocity is practically constant for the time considered) we may take the distance between any two positions of the ram, 0 and 2 for instance, as a measure of its velocity at a point half way between these two positions.

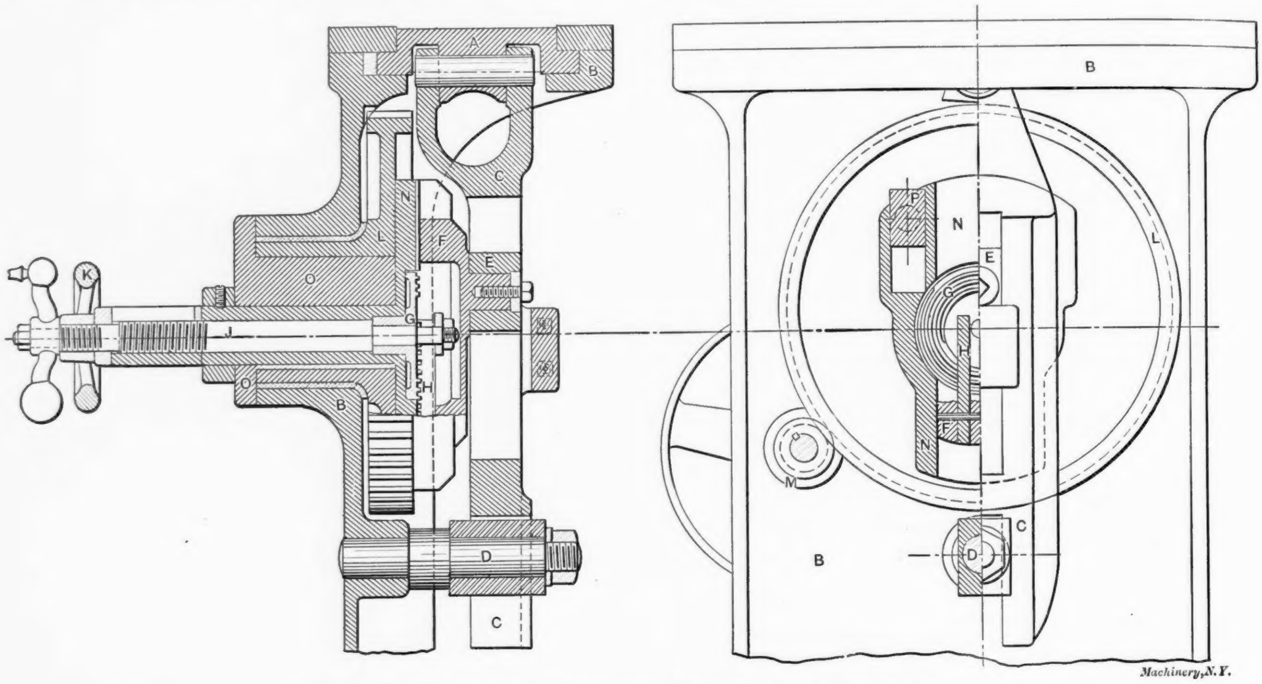


Fig. 3. Construction of the Quick-return Mechanism for Driving the Ram.

In this way the diagram in Fig. 4 was constructed. Horizontal line $O\ O$ is drawn, crossed by vertical lines 1, 3, 5, 7, etc., at equal distances, representing the equal elapsed periods of time when the driving wheel occupied positions intermediate between stations 0, 2, 4, 6, etc. As before intimated, we lay off on line 1 a distance above line $O\ O$ equal to the distance between positions 0 and 2 of the ram as measured on line $A\ B$ in Fig. 2. In a similar way on line 3 in Fig. 4 we lay off a distance equal to that between stations 2 and 4 of line $A\ B$ of Fig. 2 and so on up to line 11. Now, on line 13

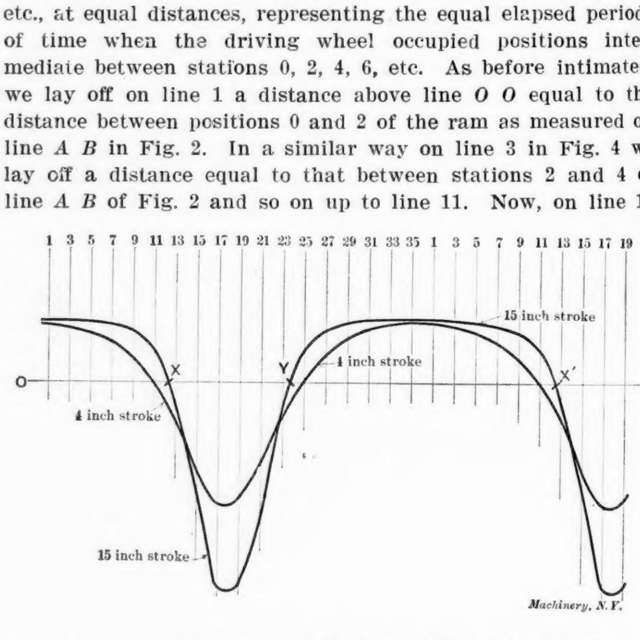


Fig. 4. Velocity Diagram for the Tool for 15-inch and 4-inch Strokes.

we should lay off the distance between stations 12 and 14 on line $A\,B$, but it will be noticed that in measuring the distance in serial order from the lower number to the higher we have commenced to measure backward. This we will consider as giving a negative value to our distance, so it must be measured off below the datum line in Fig. 4. Proceeding, on line 15 a vertical downward distance is laid off equal to that between stations 14 and 16 of $A\,B$ and so on, the dimensions again becoming positive at line 25. After station 35 is reached we may commence over again in order not to

end the curve at an inconvenient point. Through the points thus determined we will draw a curve represented in the diagram by the 15-inch stroke line.

This curve shows us what we want to know. It shows us that between X and Y the velocity is negative, that is to say, the tool is on the backward stroke, while between Y and X' the velocity is positive, when the tool is advancing. The relative lengths of XY and YX' will then give us the relative time taken for the cutting stroke and the return stroke. Besides this information (which might have been otherwise obtained) the shape of this 15-inch stroke curve tells us what we want to know about the mechanism as a quick return device. It will be noticed that the top of this curve is remarkably flat, thus showing that the velocity is nearly constant throughout the greater part of the length of the cutting stroke. Since this is one of the things to be sought for in a movement of this kind we may conclude that in this respect the mechanism is fulfilling its function in an exceedingly satisfactory way.

If in Fig. 2 we had taken the diameter of the crankpin circle as that required to give the ram, say, a 4-inch stroke, but had followed in all other respects the procedure just described, we could obtain a curve on the diagram giving relative velocities for different positions under these circumstances. Such a curve is shown in Fig. 4, but for the sake of comparison with the 15-inch stroke curve this 4-inch one has been exaggerated or drawn to a larger vertical scale, so that its maximum forward velocity corresponds nearly to the maximum forward velocity of the ram in the 15-inch stroke. This vertical exaggeration, as we may call it, corresponds to the action that takes place when the belt is shifted to a smaller step on the driving cone for the short stroke, so that the action is entirely justifiable.

In the usual shaper mechanism, the quick return motion rapidly loses its effectiveness as the stroke is shortened. The introduction of the intermediate Whitworth device, however, preserves to a large degree the quick return characteristics even at this very short stroke, as well be seen from an examination of the curve. A similar analysis of a plain slotted link arrangement would not have shown as satisfactory a result.

General instructions for using this method of investigating velocities may be given in these words: By construction, show the position of the driven member at each of a number of small equi-distant intervals of time. Measure in regular order the distance between the stations thus obtained, and mark off these distances on successive ordinates on cross-section paper, measuring the distance above the datum line for measurements taken in one direction and below the datum line for measurements taken in the opposite direction. If a curve is drawn through the points thus obtained, it will be a fair representation of the velocity of the moving elements whose action it is desired to study, providing the work has been carefully done and the stations have been taken at reasonably short distances apart.

* * *

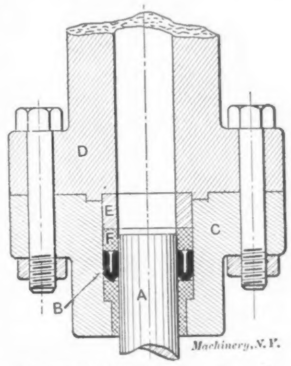
As the subject of endurance of taps has of late been given some attention in MACHINERY, it would perhaps be well worth mentioning that Mr. George M. Bond, who has been intimately associated with the establishment of gages for the U. S. standard thread, said in a lecture before the Franklin Institute in 1884 that a certain nut-manufacturing concern by using the U. S. standard thread form had been able to cut the threads of 120,000 nuts with a tap of 3/16 inch diameter. If we assume that the thickness of a 3/16-inch nut is about 0.2 inch the continuous length of thread cut would be 24,000 inches, which certainly is remarkable for this size tap.

* * *

The watering of railroad stock with consequent results upon rates is exemplified in the case of the Great Northern which is now paying dividends of 7 per cent annually on $150,000,000 capital stock and, it is claimed, intends to pay the same rate of dividend on the capital stock after it is enlarged as proposed to $210,000,000. The road's patrons, mainly the people of Minnesota, will probably have to pay the difference, which would be $4,200,000 a year, very likely without receiving any direct benefits.

HYDRAULIC STUFFING BOX PERMITTING OF EASY RENEWAL.

Designers and users of hydraulic machinery sometimes prefer the use of a stuffing box with soft packing for piston rods and rams of moderate size, even though it is less effective and wears much more rapidly than does the U-packing ring of leather. The objection to the leather packing is that it has seemed necessary to install it in such a way as to make renewal of the packing rather difficult. That this condition is an avoidable one will be seen from the accompanying cut, which represents the ram and packing of the steam intensifier used with the rapid-action forging press built by Davy Bros., Ltd., of Sheffield, Eng. The ram A is shown at the lower extremity of its stroke. It and the packing B are supported by the sleeve C, which is an extension of the cylinder D. The joint between C and D is one easy to make or break, and to keep tight. Within a counterbore formed in the sleeve C are inserted two rings, E and F, above the U-packing. To renew the packing it is only necessary to lower the ram to the extreme position shown, remove the bolts holding the sleeve C to the cylinder and then drop the sleeve out of the way. Ring E may now be withdrawn from the sleeve and slipped out sidewise, there being room enough left between the top of the ram and the lower face of the cylinder for this purpose. In the same way F may be removed and with it the packing. After this is renewed the operation is reversed, rings F and E are inserted, bushing C is reclamped to cylinder D, and the press is again ready for work. This operation can be performed in a few minutes, whereas without this device the insertion of a new leather necessarily occupies a good deal of time, involving considerable labor and interfering with the use of the press.

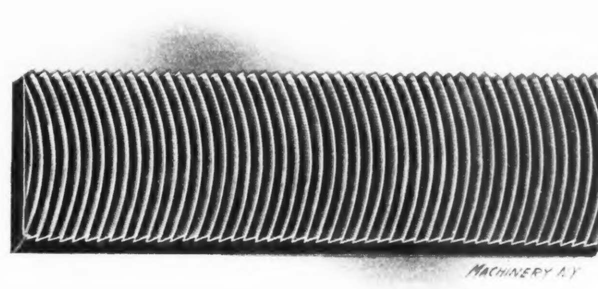


Hydraulic Stuffing Box Permitting of Easy Renewal.

* * *

A CIRCULAR CUT FILE.

What is stated to be a simple and radical improvement in the manufacture of files consists in the method of circular cutting adopted by the Patent File & Tool Co., London, on the files manufactured by them. The shape of the teeth and method of cutting are shown in the accompanying illustration, taken from the *Engineering Review*, London, January, 1907; it will be seen that the grooves are semi-circular in outline and are cut very deep. It is stated that this method



Circular Cut File.

of tooth formation enables the file to cut without slipping or running to the side, and insures superior cutting qualities to those possessed by the ordinary file, besides enabling the tool to retain the cutting edge for a longer period. Furthermore, owing to the shape of the teeth, which tends to urge the chips toward the outer edge, the file is said to possess self cleaning properties, and can be used on all metals including brass and aluminum or even marble. The file can be re-cut four times at very little cost, whereby an economy of 36 per cent is claimed over the ordinary file.

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IMPERATIVE NEED OF SAFETY DEVICES.

A few years ago *Life* printed an alleged humorous cartoon labeled "Traveling Incog." The artist's interpretation may be easily imagined; it was a gentleman attired in traveling costume with silk hat, bag, etc., who was cheerfully passing between a train of so-called gears and emerging with a row of gear tooth impressions on each side of his anatomy. The horrible reality in some degree is witnessed only too often in our shops, mills and factories where gearing is allowed to run unprotected. Equally as deadly may be unprotected belts and the setscrews of whirling shafts; and "monkeying with the buzz-saw," meaning almost certain injury, has come to be a current expression. A great deal of educational work has been done in the past few years in demonstrating the need of protective devices for machinery, especially machinery that is worked by inexperienced operatives. There is still a wide field for improvement. It is not an uncommon thing to find machine tools with traps for unwary fingers. Many a machinist notes with regret missing fingers which he can ill spare in his daily work. The recent Exposition of Safety Devices held in New York showed a large number of protective appliances, some of which, of course, were impracticable; but the majority of them could, with some modifications, be used in places where now nothing of the kind is in common use to save employes from serious accident or perhaps a terrible death.

* * *

THE "HUSTLER."

In times of industrial prosperity, when the possibilities of the shop cannot keep pace with the abundance of business, the hustler looms up in the foreground. The hustler is not necessarily a man who performs any more work than do his fellow workers. As a rule, he simply possesses the quality of always being exceedingly busy, and making his superiors believe that the amount of work performed is directly proportional to the swiftness of his motions when he often aimlessly, and nearly always unsystematically, hurries around the shop or hustles about his job. There is no objection to a man working "for all he is worth." Lots of men do who never aspire to enter the hustlers class. It is not necessarily how busy a man *seems* to be that determines his real value. It is the intelligence, thoroughness and interest with which he performs his work which will count in the long run. A man's superiors may be deceived for a time, and in busy seasons for a long while, by the amount of effort expended, but when the high tide recedes, the hustler is likely to be measured more correctly, and more time given to the analysis of the results produced by hustling methods. Then, recognition of superiority is more likely to be awarded to the man who performed his duties with less ostentation but with more earnestness of purpose—the man who strained his intelligence more than his muscles and who would rather know himself that he was doing a thing right and doing his best, than impress upon his foreman the magnitude of his efforts.

* * *

SPECIALIZATION IN TRADE LITERATURE.

The time has come when specialization is necessary not only in the shop and in engineering activities in general, but also in the literature which deals with these subjects. Authors of books on technical matters, for instance, have tried in the past to treat a whole branch of engineering in a single volume, the result being, of course, that we get a little of everything, but nothing of real value of anything. It is likely that this will change little by little. The demands of specialization will make themselves felt, and we may hope for more complete treatment of particular subjects. This would be very desirable, as it is often now the case that technical books tell little or nothing of what is not already known to anyone who on account of his occupation is engaged in that certain class of work which is the subject matter of the book. What is true of books is no less true of periodical trade literature. A trade paper, while of course following the general trend of progress in engineering matters, should devote its energies to one particular branch of activity. By doing so, it is possible for the journal to closely follow the progress of the world in its chosen field, and give information of far greater value than when trying to deal with all the branches of engineering in a limited space. Specialization is the necessity of our time, and it is the one great cause of our present development.

* * *

ENCOURAGING PUNCTUALITY.

Every superintendent and foreman has probably had more or less painful experiences due to the difficulties that are met with in regard to the tardy habits of some of their men, who, as long as they are paid by the hour, consider it perfectly proper if they stay out half an hour or an hour in the morning, or the whole forenoon or the whole day, as the case may be, without having given any previous notice. The business of a firm may be seriously retarded by the actions of such of their men who have no sense of responsibility, and although in many cases the men may feel that they are treated in such a manner as to relieve them of all responsibility toward the firm, it is a poor policy for a man not to try to fill his place conscientiously, at least in regard to attending faithfully to the work he has once contracted to do. As a cure for this evil the system of a large English firm recommends itself. This firm puts a premium on punctuality and attention to business. No moralizing can do as much to inculcate good habits in a man as does the realization of a sure and immediate reward. For this reason the concern in question has posted notices to the effect that each man in the employ of the company who, during each full month, is not absent nor late to his work, will be granted one full holiday with pay. It is stated that this offer shows very gratifying results and that the firm by no means thinks that what might be deemed a liberal offer is in any way infringing on the paying qualities of the business. A large concern in New England has also established a system of rewarding faithful attendance in that each employe will be paid 2 per cent of his total wages between the first of January and the first of July in a lump sum on the first day of the latter month, provided that the employe is not absent from work more than six working days, except for sickness, during the period mentioned. It would be gratifying if attempts to encourage attention to work, and rewards for faithful service were more general, because the habit of punctuality, once established, will follow the man who has been caused to adopt it, through life; at the same time it is safe to say that the relation between the employer and employe would be more congenial were there a visible appreciation of good habits and exerted efforts.

SYSTEMS AND RED TAPE.

It is exceedingly difficult to devise and adhere to a shop system without introducing a certain element of "red tape." A limited amount of red tape may not be objectionable. It simply impresses the importance of a systematic order of things. But when, as too often is the case, it goes so far that it seems that the system with all its red tape is the one important factor, and the thing systematized is of only secondary value, then is the time to find out whether so much of it is not "too much of a good thing." It happens, though we hope it does not happen in very many shops, that economy in production is sacrificed for adhering to the rules which cannot be changed without changing the system; and changing a system is by some office men looked upon as little short of sacrilege.

Let us by all means have systems, but let not the system become greater than the thing systematized, the economical production of the shop. Let not the part become greater than the whole. Make rules, but do not make them so hard and fast that they can under no circumstances be adapted to suit special requirements. And by all means, let us not be afraid to change the system, radically change it, if necessary, even if it involves a great temporary expense, provided that in the future it will contain less red tape and fill its purpose better. Finally, let us recognize that the system is not the end, but only a means to an end, and should remain in this station.

* * *

EFFECT OF VELOCITY ON THE FLOW OF PLASTIC METALS.

We recently had an interesting correspondence with one who was confronted by the question of whether the velocity with which the compression of a certain bronze piece was effected made any material difference in the pressure required. For example, take the case of a bronze cylinder 4¼ inches diameter, 4 inches long with a 2-inch axial hole; a test under a hydraulic press showed that a maximum pressure of 250 tons or nearly 23 tons per square inch sufficed to compress the cylinder to a length of 3½ inches, the velocity of the ram being 0.35 inch per minute. Now it is known that at below, say, 25 inches per minute, the rate of tension does not materially affect the ultimate stress required, and the same is supposed to apply in compression. In this case there was a condition of having greatly increased the velocity by the use of a heavy crank and knuckle-joint press, and the machine had broken down doing work for which it was recommended. The makers of the press claimed that the higher velocity at which the work was done (over 140 times the rate of the hydraulic press) imposed a much heavier pressure on the gate than that for which the machine was designed, hence it broke down under a pressure considerably greater than the guaranteed strength. The one on whom it devolved to make a comparative test in the interest of the owners and users of the press to show whether the failure was due to the high velocity or to weakness of the press, was not a technically trained engineer, but nevertheless he devised a simple apparatus which demonstrated conclusively that the higher velocity did not make a material difference in the pressure required to compress the bronze piece to the required degree. In making the test he supported the specimen on the middle of a heavy steel bar which in turn was supported at the ends, thus putting it in the condition of a beam supported at the ends and carrying a load at the center. The deflection of this steel beam was measured by a micrometer, while a specimen was compressed under a slowly moving hydraulic press, noting at the same time the pressure, in tons on the gage, required to effect the deformation. Then a similar specimen was compressed under a crank and knuckle-joint press, having a gate velocity of 50 inches per minute and the deflection of the steel bar was again measured for the same amount of compression of the specimen. It was found to be almost exactly the same, showing that for the velocity of compression mentioned it did not make any material change in the pressure required.

One reason for speaking of this matter is that, aside from the more or less important fact that velocity within the range indicated did not change the pressure required, here was a technically untrained mechanic who was required to make a test to ascertain a fact, but who was not provided with any apparatus save that which any ordinary shop provides. His method of making the tests might, in some details, be subject to criticism, but in the main they show exactly what he desired to show and served the purpose in most essential particulars. A trained engineer without that very necessary accompaniment, "horse sense," would very likely have required an expensive apparatus to have made his comparative tests, but they would have been little better than these, except that they perhaps would stand better in a case at law because of having recognized authority back of them.

* * *

WHO PAYS THE PRICE?

A Wall Street circular the other day contained the comforting information, based upon the calculations of what we suppose to be a Wall Street expert, that the royalties to be paid for the iron ore deposits leased by the United States Steel Corporation from James J. Hill will in 50 years amount to $1,190,000,000. This represents the earnings of an army of 26,000 men paid at the rate of $3 a day for a period of 50 years. The country is in other words to feed, clothe and house an army of 26,000 men for 50 years simply in order to pay Mr. Hill or his representatives for the permission to dig out the iron ore, and by the industry and ability of millions of men turn it into usefulness. We mention this simply as a matter of fact, and not because we find any fault with Mr. Hill or anyone else who simply takes advantage of long established customs. But what do we pay this enormous sum for? For any great benefit conferred upon the country by Mr. Hill? By no means. These ore deposits would have existed and been equally useful had their present owners never been born.

Who are to pay this royalty? All those who use steel, in the first place the railroads and machine builders of the country, secondly, all those who use railroads and machinery, and finally all who use the products of machinery. We do not call attention to this fact because we protest against it; that seems more or less useless. We simply recognize it as our duty to call attention to the reason why raw materials are increasing in price although the processes of obtaining them from nature's storehouse is constantly becoming cheapened and simplified. Our American manufacturers and machine builders pay the price of a monopoly, and this price is still further augmented by our fiscal system of preventing foreign steel to enter our market at a penalty of from 8 to 12 dollars a ton. This penalty is exacted in the name of protection to infant industries. In order to protect such tiny industries as those connected with our steel production, comprising one of the most gigantic and powerful corporations in the world, our other industries which are purely competitive, and who rely entirely upon skill, inventive ability and business capacity for their existence, must be curtailed and suffer. The retarding action is perhaps not so much in evidence in the machine tool business whose systematizing and standardizing have made it possible for the business to prosper in spite of adverse conditions in regard to high raw materials. But let us not be blind to what it has meant to our shipbuilding industry. First we kill off this enterprise by protecting an infant industry until no one will undertake to build ships here when they can be built by cheaper raw material so much more economically elsewhere. Then we think that we must subsidize our ship-building interests, thus affording a new opportunity for the steel business to exact the tribute incidental to lack of competition.

If there be any infant industries crying for protection, although we do not know of any, let us give them protection. But why should we advocate the continuation of protection to powerful monopolies who profit by their ability to demand tribute from competitive business enterprises? Let us remember that we all have prospered in the past because of our inventive ability and enterprising spirit, not because we have undertaken to foster monopolies. And we have great faith in the capability of American industries to prosper by the same means henceforth.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Rates of duty on machinery and machine tools imposed by various countries have been compiled by the Bureau of Manufactures, Department of Commerce and Labor, and are published serially in the *Daily Consular and Trade Reports*, commencing February 1, 1907.

Iron sheets coated with aluminum are now being manufactured in considerable quantities, and have been found to be very durable under long exposure. These aluminum-coated sheets ("aluminumized" iron) will probably supplant galvanized iron for many purposes.—*Valve World.*

Monel metal is a recently patented nickel-copper alloy having remarkable strength, wearing quality and resistance to corrosion, especially the latter in the presence of hot gases. It has a tensile strength of about 95,000 pounds per square inch. It is composed of nickel, 75 per cent, copper, 23.5 per cent, and iron, 1.5 per cent. It is being used in the Knox automobile engine for the exhaust valves with marked success.

The interstate commerce commission is preparing to make an investigation into the rates charged by the express companies. Within a few weeks, hearings will be held at Washington and Chicago, and probably at New York and other points. It has been stated that complaints have been received from all parts of the country that the rates of express companies are excessive, and that, therefore, the commission will conduct practically a general investigation.

The number of locomotives built at the Baldwin Locomotive Works, Philadelphia, Pa., in the year 1906 was 2,652, comprising 201 electric and 2,451 steam. Of the 2,451 steam engines, 133 were equipped with compound cylinders. This represents the largest output of the Baldwin Locomotive Works in any year of its history. The number of men employed by the works, exclusive of the Standard Steel Works, at this time is about 19,000.—*Iron Age.*

At the present time, when platinum prices have reached a height making the use of the metal prohibitive in many instances where it would be desirable, the reports from New Zealand that platinum has been found in that country is demanding great attention. The analysis of certain proofs has given a limited amount of platinum, but it is expected that even richer ores may be found in the Pounamu district on account of the geological formation in this part of the islands.—*Industritidningen Norden.*

An interesting example of extreme human performance is that recently done in Paris by the victor in a peculiar race. One hundred and twenty contestants took part in a race up the 730 steps leading to the second stage of the Eiffel tower. The winner made the distance in three minutes and four seconds. Taking the weight of the winner as 150 pounds and the lift of each step as 8 inches, a simple calculation shows that for this period he exerted the almost incredible average of 0.71 horsepower.

According to the *Horseless Age* alcohol instead of gasoline was tried on a recent trip with a Dragon car, making a run between New York and Philadelphia. The result, however, was not quite as gratifying as one might wish for. About three times as much alcohol was used as would have been used of gasoline, and the power from the motor was not quite as great, but this of course was due to the fact that the compression was not high enough for alcohol, as the engine was not specially designed for the use of this fuel.

The Carnegie Institution, of Washington, D. C., has made a grant of $3,000 a year for a period of four years to Dean W. F. M. Goss, of Purdue University, Lafayette, Ind., for the purpose of determining the value of superheated steam in locomotive service. This is the second grant which the institution has made to Dr. Goss. While given to him personally, its effect will be to stimulate and to make more effective the work of the Purdue locomotive laboratory. The result of Dr. Goss's previous research under the auspices of the Carnegie Institution, which was for the purpose of determining the value of different steam pressures in locomotive service, is now in press.—*Railway Age.*

The requirements for the installation of a successful windmill electric plant are stated in a concise form by Mr. W. O. Horsnaill, England, as follows: Ascertain first the average daily load in ampere hours during the periods of maximum current consumption. Then provide a storage battery for a capacity at least double this output, install a dynamo of sufficient capacity to charge this battery for 12 hours, and lastly select a windmill sufficiently large to run the dynamo at full load with a 10-mile per hour wind. Fit the windmill and driving gear to the dynamo by ball or roller bearings throughout so as to, as far as possible, eliminate frictional loss.

A learned German professor has devoted considerable time to the measuring and calculating of the value of the electrical energy of a lightning. We are now comforted by the information that a lightning of a duration of 0.001 second and a length between the charged bodies of two-thirds mile represents an electrical energy corresponding to a commercial value in Berlin of 650 dollars. Now there is no more excuse for lack of power for manufacturing purposes in a country with so frequent thunderstorms as the United States, provided, of course, that our professor does not forget also to tell us how to get hold of the lightning.

The *Industrial Magazine* is devoting a short note to the tests now carried on at Charlottenburg, Germany, with the new "Osram" electric lamp. In this lamp the carbon filament for incandescent lamps is replaced by fine wires of wolfram, which are claimed to employ only one-third of the energy heretofore required. The tests show that after having been used 1,000 hours, there was an average loss of brilliancy of 6.3 per cent in the case of 25 candle power lamps, and 3.6 per cent in the 32 candle power lamps. The only drawback with this lamp is that it can be used only hanging downward, but the inventor expects to be able to overcome even this disadvantage.

The Department of Public Works in Prussia has called the attention of the railways to certain defects which have appeared in the locomotives furnished with superheaters, and has suggested means to remedy the defects. It has been found that in the steam boxes of the Schmidt superheater the projecting ends of the steam tubes rust easily, and rapidly weaken, with the result that the crown plates of the superheating chamber become distorted and leak. Drainage channels have been tried with valves opening into the steam box, and these valves open automatically by the action of spiral springs when the steam pressure is shut off. The effect of the drainage valves has also been to maintain the strength of the plates.—*Practical Engineer.*

A company has been formed at Prague for the manufacture of artificial rubber, called "Zackingummi," invented by a Swedish engineer. It is stated that the cost of this material is but a third of that of rubber, and that it has been used for various purposes, such as for filling motor car tires, to which it absolutely attaches itself, for packings, etc. It is stated that this material has the advantage of being unaffected by the atmosphere, and that it will not perish as does rubber. Tests on Zackingummi have been executed at the official testing station of the Stockholm Engineering College, which show

that it is many times stronger than rubber, while for use in connection with vacuum brakes the Swedish State Railways are said to prefer it.—*Times Engineering Supplement.*

The following additional information is of interest regarding the Poulsen wireless system of telegraphy which we mentioned in the February issue. Stations have been built in Denmark in which syntonization as close as one per cent has been attained; that is to say, a pair of stations can operate with wave lengths of 600 meters, and another pair in the same territory with waves of 606 meters, without interfering with each other. Waves having lengths of from 300 to 3,000 meters can be conveniently generated, so that several hundred stations may operate within the same sphere of influence, it is said. As more energy is generated with the longer wave lengths, these are used for the long-distance work, and they naturally go with the taller masts, while the short waves and lower masts are employed for the near-by signaling.

The *Times Engineering Supplement* gives some details regarding the successful experiments with wireless telephone between Berlin and Nauen, Germany, a distance of twenty-five miles. The messages were sent from Berlin to Nauen, and as a check on the accuracy of the signals an ordinary telephone wire was employed for return messages from Nauen to Berlin. After the attention of the Nauen operator had been secured by striking with a rod of metal on the metal mounting of the microphone, beginning with the customary "Hallo" a series of numbers were called out into the microphone. At first single numbers were repeated several times into the speaking trumpet attached to the microphone, and the numbers were called back from Nauen by means of the ordinary telephone. Next sets of figures were selected and these speedily came back correctly by the ordinary telephone. There were occasional interferences or interruptions which caused a suppression of whole groups of figures, but when these were repeated, correct results were obtained. Subsequent tests were made by calling numbers and letters both singly and in groups. Lastly the attempt was made to transmit an entire sentence and this was, on the whole, intelligently and correctly conveyed.

A very good and comprehensive way of expressing the advantages and disadvantages of various types of steam engines is given in *Power*, January, 1907, by W. M. Wilson. The types of engines taken into consideration are high speed and low speed reciprocating engines, Parsons steam turbines, De Laval turbines and engines with condensing plants. The advantages and disadvantages of each are stated as follows:

High-speed Engines.

Advantages.	Disadvantages
Low initial cost of engine.	Large coal consumption.
Moderate cost of generator.	Large boiler capacity.
Cheap type of boilers.	
Moderate floor space.	

Low-speed Engines.

Advantages.	Disadvantages.
Low coal consumption.	High initial cost of engines.
Small boiler capacity.	Expensive type of boiler.
	Large floor space.

Parsons Turbines.

Advantages.	Disadvantages.
Moderate initial cost of turbine.	Expensive type of boiler.
Small floor space.	
Small boiler capacity.	
Low coal consumption.	

De Laval Turbines.

Advantages.	Disadvantages.
Moderate initial cost of turbine.	
Small floor space.	
Moderate boiler capacity.	
Moderate coal consumption.	
Cheap type of boiler.	

Engines with Condensing Plants.

Advantages.	Disadvantages.
Decreased coal consumption.	Initial cost of condenser.
Decreased boiler capacity.	Cost of condensing water.

CAST IRON MAGNETS.

Electrical Review, January 5, 1907.

Some time ago it was pointed out by Professor B. O. Peirce that chilled cast iron was an excellent substitute for the more expensive steel alloys generally used for making permanent magnets. He found that with a careful heating and chilling he could prepare magnets which while possibly not suitable for the finest measuring instruments, still served admirably for constructing less elaborate devices. These magnets had retentivity comparable with that of the more expensive steel magnets.

Investigations have also been carried out by Mr. Albert Campbell with a view to determine the value of such magnets. He heated cast iron to about 1,000 degrees Centigrade, and quenched it in water. Several of the cast iron magnets thus obtained gave better results than were secured from some steel magnets, although they were inferior to those made from another brand of magnet steel. While the experiments do not agree with one another closely, they show that excellent permanent magnets may be prepared from cast iron. For certain instruments, where constancy over a long period is not essential, cast iron will undoubtedly be satisfactory; but in many types of electrical measuring instruments it is very necessary that the magnet remain constant in strength for a long time. To secure this, careful treatment and seasoning is necessary, and it has not yet been shown that satisfactory results may be obtained from cast iron when the requirements are of this kind.

TIDAL MOVEMENT POWER STATION.

Engineering News.

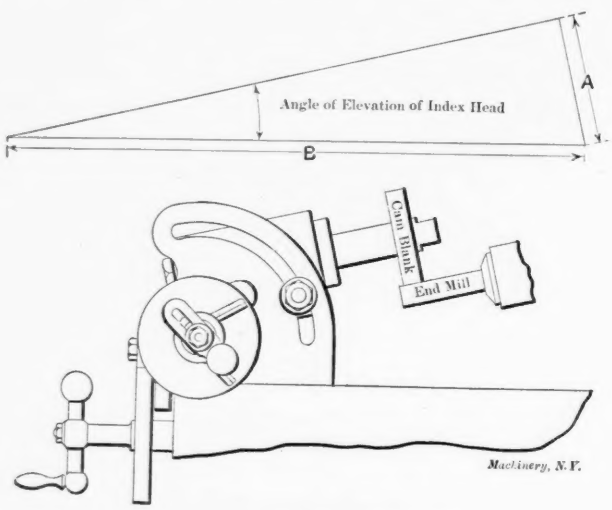
At various times there have been experiments made for using the enormous quantities of energy in the tidal movement of the ocean. So far experiments have had but little success, but a new attempt about to be made at Rockland on the coast of Maine seems to be more promising. An air-compressing plant will be installed and the power will be transmitted by pipe lines in the form of compressed air to the place where it is to be used. It is claimed that it is practical to arrange for storage chambers sufficiently large to store the air in order to cover that period of time at the flow and ebb tide when the compressors would either not work at all or else work at such low efficiencies as to be commercially impracticable. Contrary to the usually preconceived notions, it is practicable to transmit compressed air through pipes, long distances, with comparatively slight losses. It has been demonstrated by the Popp system, in Paris, that the leakage is very slight, and four years' experience, at Norwich, Conn., shows the same result. Hydraulically compressed air, being a perfectly dry gas, the frictional resistance, in good, smooth-coated pipe, is remarkably low, and velocities of 50 to 70 feet a second are admissible. The cost of pipe lines is not so greatly in excess of electrical transmission lines, when the cost of step up and step down transformers, etc., are taken into consideration. The scheme at Rockland having been financed, work will begin in the early spring on the construction of the dam and the laying of pipe lines to the quarries of the Rockland, Rockport Lime Co., to the power-house of the Rockland, Thomaston & Camden St. Ry., and to several cities in whose streets distribution mains will be laid the same as gas pipes. It is expected that the plant will be completed in the fall of 1907.

AN INGENIOUS WAY OF MILLING CAMS.

American Machinist, January 17, 1907.

Cams having regular rise may be milled, so to speak, automatically in the milling machine by placing the cam blank on the dividing head spindle and gearing the head for spiral milling, while an end mill is put into a vertical milling attachment of the type which is adjustable to any angle in the vertical plane, as shown in the cut. The end mill is of course placed at an angle with the table of the machine, this angle being determined by the rise of the cam and the forward feed of the milling machine table for one turn of the index head spindle. It is evident that when the table is feeding forward the cam blank moves along the cutting edge of the

end mill, and as this latter is stationary, the radius of the cam will be constantly diminished. The problem of finding the inclination at which to set the index head may be most easily explained by the diagram in the cut. In a right-angle triangle, as shown, the hypothenuse B represents the distance that the milling machine table is feeding forward while the index head spindle makes one complete revolution. The side A in the triangle represents the rise that the cam to be milled would have in one complete turn. If we now want to cut a cam having a rise of ⅛ inch in 300 degrees, then the rise in a complete turn will of course be to ⅛ in the same proportion as 360 is to 300, or in other words the rise for a complete turn equals $\frac{360}{300} \times \frac{1}{8} = 0.15$. This distance 0.15 inch is the side A in our diagram. Suppose that the slowest lead of the milling machine, or the amount that the table moves forward while the index spindle makes one complete turn is 0.67, then $\frac{0.15}{0.67} = 0.224$ must equal the sine for the angle to which to set the dividing head which in this case will be approximately 13 degrees. The milling machine with its end mill must of



Ingenious Way of Milling Cams.

course be set to the same angle as the dividing head if we wish the edge of the cam to be parallel with the shaft on which it is to be placed. When the diameter of the cam and the inclination of the head admits, it is advisable to mill on the under side of the cam, as that brings the milling cutter and table nearer together, and increases the rigidity, besides making it easier to see any lines that may be laid out on the flat face of the cam. At the same time the chips are prevented from accumulating on the work. In many cases it will of course be necessary to use mills of extra length in order to permit the cam blank to move the necessary distance along the cutting edge of the mill.

ALUMINUM WIRE FOR MAGNET WINDINGS.

Industritidningen Norden.

The natural oxide of aluminum forms so effective an insulation that magnet windings of uninsulated aluminum wire have proven feasible. The thin film of oxide on the wire will insulate it against a potential of 0.5 volt. As in the case of windings for direct current there usually is no more difference between the voltage in two adjacent coils than 0.06 volt, it is entirely possible to depend upon the insulation of the oxide alone. The different layers of the winding must, of course, be provided with some other means of insulation, because of the greater difference in voltage between these. Paper wound wet between the layers has proven effective for over 200 volts, and extra oxidation has been secured by dipping in a chemical bath for higher potentials. In most cases, however, an artificial oxidation is not necessary as the dampness of the air alone will produce the necessary amount. In the case of alternating current, the film of oxide is produced slower, and for this reason it is claimed to be of advantage to let a direct current go through the windings for some short time, say 15 minutes, after the winding is completed. An advantage with windings of this kind is that the film of oxide increases at the same time as the insulating material between the layers is losing its insulating qualities, but this increased oxidizing is not enough to in any way interfere with the conducting qualities of the aluminum wire. As no insulation is necessary, there is also a possibility of using the larger diameter of wire necessary on account of the smaller conductivity of aluminum without occupying any more space, and square wire has also been used to advantage, whereby space is saved to a great extent. Comparing the price of copper and aluminum, the former wire being insulated, there have been cases where the saving in expenses has amounted to from 25 to 50 per cent and the saving in weight from 50 to 60 per cent. The method is introduced by a German engineer, Hopfelt, and practical experiments seem to indicate that the new method will actually prove itself to have a great practical value. It seems, however, to be indicated by the experiments that magnets with windings of insulated aluminum wire are not feasible, or at least not advisable, for warm and very dry places, as dampness is the necessary condition for the production of the film of oxide.

UNIQUE EXPERIMENT IN TECHNICAL EDUCATION.

Iron Trade Review, December 27, 1906.

In this article Herman Schneider, dean of the College of Engineering of the University of Cincinnati, describes an unusually interesting plan which is being tried by that school, jointly with the various mechanical, electrical and chemical industries of the city in which it is located. The university is supported in part by direct taxation, so the authorities of the school have always felt that it was the duty of the institution to be of the utmost practical service to the community, rather than to concentrate its energies on the training of a few select scholars. With this idea in mind, the co-operative plan of teaching various branches of engineering has been undertaken. The students under this system work alternate weeks in the shops of the city and at the university, working in pairs, the two men of a pair alternating with each other at the shop and school. That is to say, during one week Mr. A is at the shop and Mr. B is at the school; the following week Mr. B is at the shop and Mr. A is at the school; Messrs. A and B both carry on the same work on the same machines in the shop, one taking up the work where the other leaves it. The course is six years in length, during which time all the subjects taught in the regular four years are given in an intensified form. Besides this each boy has served the regular apprenticeship course of every young man who intends to become a machinist.

It is to be distinctly understood that these students must have for entrance to the course all the educational preparation usually required, and that they receive as thorough a literary, scientific and mathematical training as is given in the best engineering courses. To make sure that the applicants for this training are of the right caliber, high school graduates are required to begin work in the shops in June, continuing their employment through the summer preceding their entrance into college. Thus, those who have not the necessary stamina are eliminated before the college work begins. It is found that most of the young men during this course are of the worthy class who desire to receive severe theoretical and practical training, and who also need to have the financial assistance which their pay as apprentices will give them.

The plan, so far as the university is concerned, went into effect last September. The class started with 30 young men who had been working all the past summer in the shops. About 45 began in June. Of these 15 were country boys, not one of whom has quit since he entered the shop. All the defections during the summer course were among the city boys.

Many doubts were expressed as to the practicability of this scheme. It was said, for instance, that the boy returning to the shop after a week's absence would be slightly impaired in skill on account of that absence, and that the students going to the university after a week's work in the shop would have

forgotten much of the work. These doubts have been dispelled. A careful canvass of the shops indicates that these men do as much work as, and in many cases more than, the regular apprentice. Most of the manufacturers have called them the best apprentices they have ever had. So far as the school work is concerned, the steadying influence of shop discipline seems to have a good effect.

Owing to the required obedience to commands in the shop, when the co-operative student is given a problem at the university, he goes to his desk and solves that problem by his own individual efforts. It is expected, also, that his shop service will have another advantage, in that the boy will learn a great deal about the mental attitude of the laborer to the employer, and about the position assumed by labor organizations toward the problem of production. Of this the four-year student is practically ignorant when he leaves college, and it has been the constant complaint of employers that college graduates are in no wise equipped to deal with that phase of shop management which concerns the employe. This regimen also seems to have had a good effect on the health of the students.

The strictly scholastic expenses amount to about $90 for the first year, $80 for the second year, and $60 for each subsequent year. The university has unfortunately no dormitory system, and students are required to find boarding places in the city, paying an average of about $4.50 per week. The wages paid by the manufacturers are not uniform. The lowest wage is $4.40 per week, increased at the rate of 60 cents per week for every six months until the course is finished, at which time the young man receives a bonus of $100. Some of the shops start their students at $1.00 per day, and in several cases shop owners are paying men for the week they are at the university. It is hoped that this question of remuneration will be standardized later. Within the last few weeks President Schneider has talked with every one of the 31 employers represented, and each one has asked him for a much larger number of these men next year.

Applications for entrance in the next year's class are constantly being received and the size of the class will depend solely on the number of men the shops and the university can take. It will probably be limited to 100 or 125 students. Applications amounting to one-fourth of this number have already been received, and it is probable that about 175 will be sent to the shops next June, of which 125 will probably begin the course next September.

THE GAS TURBINE—PRACTICAL RESULTS WITH ACTUAL OPERATIVE MACHINE IN FRANCE.

Cassier's Magazine, January, 1907.

There has of late been a great deal of discussion regarding the possibilities of producing a practical turbine by the action of gases of combustion, but the whole subject has, with few exceptions, been treated as a matter entirely in the future. It will therefore be new to many to learn that an effective gas turbine has been in successful operation in the laboratories of the Société des Turbomoteurs, Saint Denis, France, and ex-

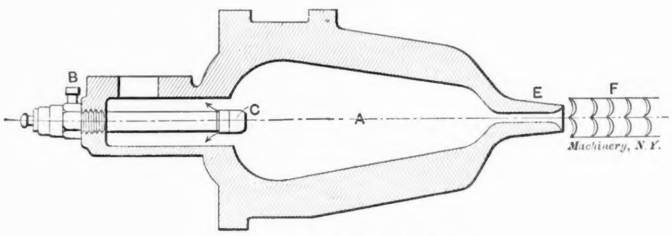


Fig. 1. Action of the Gas Turbine

periments are now conducted with this machine, not with the purpose of finding out whether it will actually work, but whether it will prove to possess a commercial mechanical efficiency.

A successful gas turbine must combine the advantages of the gas engine, including the elimination of the steam boiler, with the advantages of the steam turbine, most important of which are simplicity of construction, lightness and continuous motion in one direction. Three plans have been considered for the design of gas turbines, that is, the hot air turbines, the explosion turbines and the combustion turbines. The first of these groups, the hot air turbines are not considered to offer any real advantages; at least, investigations in this direction have not as yet yielded any practical results. In the second group, the explosion turbines, the high velocity of discharge of the gases and the variations in the pressure render it impracticable to realize more than a small fraction of energy of the jet upon the wheel. The combustion turbine is thus the form most important to seriously consider. This

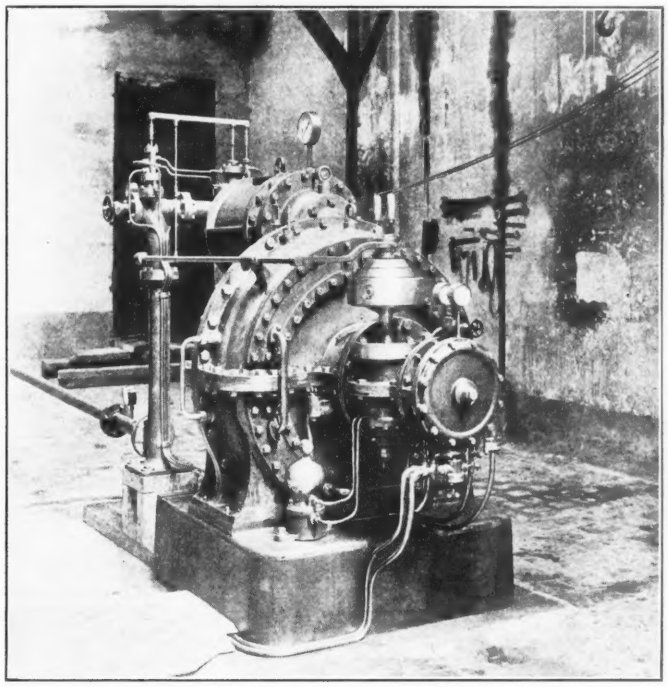


Fig. 2. Gas Turbine built by Societe des Turbomoteurs, Saint Denis, France.

machine consists in principle of the combustion chamber *A*, as shown in Fig. 1, supplied by a continuous current of compressed air and also by a continuous supply of liquid fuel (gasoline, petroleum, or the like) under pressure through a tube *B*, the mixture being ignited, when entering, by a platinum wire *C*, the combustion developing a constant temperature of about 3,200 degrees F. in the chamber *A*. The fluid products of combustion are then continuously discharged through a nozzle *E* upon the buckets of the turbine wheel *F*.

The practical difficulties to be overcome in a combustion turbine may be summed up as follows: A gaseous fluid moving at high velocity must be kept constantly ignited by a device which must not be affected by high temperatures; the mixture of the combustible and the air must be made as perfect as possible; and the injurious action of the gaseous products at a high temperature upon the parts of the turbine wheel must be prevented. A machine complying with these conditions known as the Armengaud-Lemale turbine has been in successful operation for three years in the shops of the company previously mentioned. The first machine was made from a De Laval steam turbine of 25 horsepower arranged to be operated with combustion gases instead of steam. This arrangement was necessarily crude and not proportioned in such a manner as to give the best results. It enabled, however, the conditions essential for good efficiency to be determined. This efficiency depends greatly upon the pressure and temperature of the exhaust gases. In order to obtain the best efficiency, therefore, it is necessary to prevent the cooling of the gases before expansion, for instance, by introducing steam into the combustion chamber. The difficulties accompanying high temperatures may be overcome in the case of the combustion chamber and other fixed parts by the use of a water jacket and by the employment of a refractory lining. The real difficulties are met with in trying to provide for the effect of the highly heated fluid upon the turbine wheel itself. The most practical way of keeping this wheel cool is to follow the jet of hot gases by another jet of a low temperature so that the buckets of the wheel pass successively through alter-

nately hot and cool zones. The low temperature jet found most practicable is that of low pressure steam.

The machine built as a result of the experiment with the De Laval turbine is shown in the halftone Fig. 2. It is of the same general type as the Curtis steam turbine, and is capable of delivering from 400 to 800 horsepower, according to the capacity of the compressor utilized. The turbine is operated at 4,000 revolutions per minute, the speed regulation being effected by a throttling valve in the air admission pipe for small speed variations, and by a change in the fuel supply for larger variations. The turbine wheel is arranged to be cooled internally by water circulation in such a manner that the water, being supplied by radial passages from a hub of the wheel, enters into circular channels in the body of the rim, and from there passages permit the water to enter into each blade of the turbine; the difference in specific gravity between the hot and cold water is found to make an automatic circulation in connection with the centrifugal force due to the high velocity of rotation.

KEYS AND KEYWAYS.

Zeitschrift des Vereines deutscher Ingenieure.

It is not very common in practice to determine the dimensions of keys by calculation, but rather according to the results of experience, so that great differences between the sizes used by different machine builders are not uncommon. Twenty years ago, however, a collection was made of the various key standards, and a system of average dimensions was founded on this basis. These dimensions, having stood the test of time, can be utilized as a basis for the examination of the strain to which keys are exposed. If we assume that the narrow side of the key alone has to take up the moment of rotation then the strain of these narrow sides must be about the same as the strain of the material in the shaft itself. The narrow sides are subjected to the specific superficial pressure p, while the tension k in a shaft of the diameter d is produced by the moment of rotation M. (See Fig. 1.) The lateral surface pressure Q on the key is therefore

$$Q = \frac{M}{\frac{d}{2}} = \frac{\pi}{8} d^2 k = 0.4 \, d^2 k \text{ (approximately).} \qquad (1)$$

This pressure has to be taken up by half the narrow side of the key and therefore

$$0.4 d^2 k = \frac{h}{2} lp \qquad (2)$$

The length l of the key is usually about 1 or $1\frac{1}{2}d$, the value $l = d$ being the average minimum. The superficial pressure p should not be allowed to exceed 17,000 pounds per square inch. The strain of rotation k should be taken at a lower value than in the case of shafts exposed to a pure twisting strain, since keyed shafts are almost invariably subjected to a high bending strain at the same time by the pull of belting, the pressure of wheel teeth, etc. Consequently k may be taken from 2,800 to 5,600 pounds per square inch or an average of 4,200 pounds to the square inch.

By substituting the values $k = 4{,}200$, $p = 17{,}000$, and $l = d$ in equation (2) we have approximately $h = 0.2d$. The key should therefore be sunk into the shaft and hub to a depth equal to 1/10 of the shaft diameter in each case, the depth being measured at the side of the key and not at the center.

The ordinary key offers a resistance to twist on the broad and narrow sides, the manner in which the strain is distributed between them being illustrated in Fig. 2. When the hub and shaft undergo a relative displacement through the angle w, the point A_1 on the narrow side moves toward A_2 and the point B_1 on the broad side toward point B_2. This results in a compression of the material to an extent indicated by a on the narrow side and by b on the broad side, the latter distance being about 1/6 of the former. The resistance to twist about the actual grooved surface for an equal strain on the material is proportionate to these two distances calculated on the relative dimensions of the two effective surfaces of the groove. For medium key dimensions this proportion is about 1 to $3\frac{1}{2}$, or in other words, the narrow sides are exposed to more than three times the twist of the broad sides. A key of the usual form, that is, slightly tapered and driven in place, takes up little or no strain on its narrow sides until the twisting force comes into play, but a very slight twist between the hub and shaft resulting from slight changes in form in the broad sides will bring the narrow sides into action. Whether the changes formed on the broad side exceed the elastic limit depends entirely on the care with which the groove has been cut and the key fitted. For these reasons the desire to secure both radial and tagential tension in one and the same key has led to the form shown in Fig. 3. Such a key would not be very difficult to make, the slots being given a considerable radial taper.

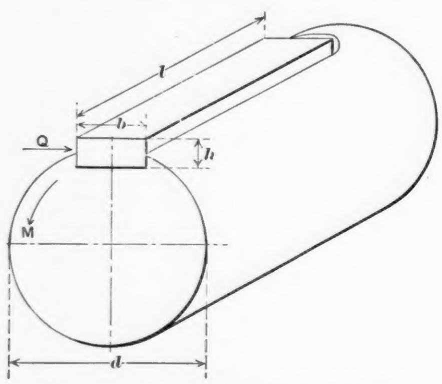


Fig. 1. Shaft with Ordinary Rectangular Key.

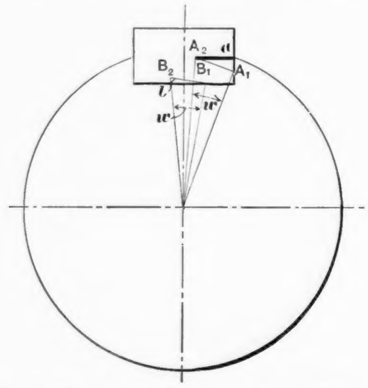


Fig. 2. Diagram of Forces Acting on Key.

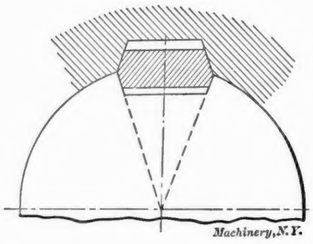


Fig. 3. Proposed Form of Key Equalizing the Radial and Tangential Tension.

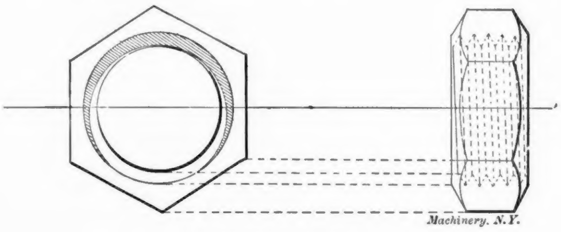
AN IMPROVED FORM OF LOCK NUT.

M. Andre Minne, in *Memoires des Ingenieure Civils*, July, 1906.

The trouble, inconvenience and expense due to the loosening of nuts are well known. A great number of remedies have been and are still daily proposed, many of which are very ingenious, but too complicated to be of everyday use. The most simple and most widely used are the ordinary check nut, the cotter pin, and the lock washer. These devices have incontestibly given good service, but they are nevertheless not sufficient to meet the requirements in a great number of cases. This is because, in a word, they do not attack the real cause of the loosening of the nuts. The cause of this loosening resides entirely in the mass of the nut, or rather in its inertia. It frequently happens that the complex vibrations to which the parts of a machine are subjected produce on the bolts which hold them together resultant forces, or rather couples, in a direction which tends to loosen the nut. We have in some cases, on machinery running at high speed, seen nuts leave their seat and continue under the impulse of the vibrations to climb up for a considerable distance on the threaded stem of the bolt. It is evident that the movement of these free nuts on their bolts could have been acquired only by the action of the couples just described on the mass of which they are composed. It can be easily shown by simple calculation that the force tending to loosening the nut under these conditions is directly proportional to the height of the nut, while it varies with the fourth power of the exterior diameter.

If one examines the very principle of the check nut, which is based on the cramping of its lower thread with the upper thread of the nut, this being the truly original and ingenious point in the device, it must be recognized that the form given to it does not allow more than a small useful effect in this direction. The whole lower surface of the nut inscribed in the hexagon being entirely in contact with the upper face of the main nut, the force is spread entirely over that surface, only a very small portion being utilized to produce the cornering or cramping of the threads on the screw; while all the surplus produces a harmful adherence of the faces in contact, rendering the nuts solid and permitting them to loosen simultaneously, the one carrying the other with it. Another effect of the simultaneous use of the two nuts has been often recognized but wrongly interpreted. Tightening of the check nut on the nut overcomes the reaction of the threads of this latter on those of the bolt and finally, if enough pressure is exerted, pushes the nut back toward the bearing on which it is seated, thus "unsticking," so to speak, the threads of the nut from those of the bolt. Thus the lower of the two nuts becomes useless and may be considered as free on its thread, so that the normal reaction of tightening, augmented by that created in screwing up the check nut, finally reacts on the threads of the latter which then becomes the true nut. That is why certain constructors have thought it best to give the check nut a thickness greater than that of the main nut.

Thus the principle of the check nut has been misconstrued, and this is why it is often found unsafe. It has even been the custom to provide it with a cotter pin, this being simply placed in a hole drilled above the nut or applied according to different systems, such as the "crown" or "castle" nut. It has then the fault of making accuracy in tightening impossible, and of being costly from the necessity for drilling the hole; it is difficult to put in place and remove, is often sheared by the vibrations and sometimes split, broken or rusted in its seat; in a word it is as inconvenient as it is unsafe.



Improved Lock Nut.

The lock washer is another device which has been used in many different ways and which possesses the good qualities of simplicity, ease of application and cheapness. The criticism to be made of it is that it destroys the accuracy of the nut, for it imposes an eccentric strain determined by the elasticity of the steel helix of which it is formed. It also destroys the flat bearing surface of the nut, which it is usually found necessary to increase by furnishing it with an ordinary washer. Thus the lock washer of the "Glover" or other design is seldom employed in accurate mechanical work, owing to the roughing of the bearing and the oblique strain on the bolt as just described. Its chief application, due largely to its low net cost, has been to the fastenings of fish plates on railroads, where it must be admitted that it has given very good service, although for more accurate work in locomotive practice it has been judged unsafe, most of the railroads having preferred to use the simple check nut.

It is then to the check nut that we return after investigating all these different systems, none of which give simultaneously the advantages of simplicity, ease of application and security. In order to give the check nut a real efficiency we have only to remedy its signal faults. This is what has been done in the check nut which we are about to describe. Its efficiency is based on the two following principles:

First, the contact between the check nut and the nut has been reduced to a section of screw thread of the nut perpendicular to its axis, so that the tightening, taking place only on the threads, "corners" them perfectly within the thread of the bolt without producing a harmful adherence between the faces of the nuts which are presented to each other. This design, at the same time, does away with a necessity for any great pressure on the check nut due to the reaction of severe tightening, it being screwed up enough to prevent unseating, by the means just described.

Second, the diameter of the check nut has been reduced so that the energy imparted by the vibrations would be much less for it than for the main nut, which tends thus, in loosening, to still more increase the tightening of the threads in contact.

A check nut constructed on these principles looks like the accompanying cut, which shows in the cross hatched portion of the plan view, the surface which is in contact with the main nut, reduced, as before explained, to a perpendicular section of the thread of the screw. The theoretical conclusions just described have been fully confirmed by the different trials of this idea which have been made since 1903 on rolling stock and tracks of different railroad companies and street railways, on automobiles, and in general on all machinery subjected to great vibrations, whose nuts have hitherto given trouble by frequent slipping. This has been definitely stopped by check nuts of this type. Among the numerous applications of this system made in railroad service in the last four years the most important that can be referred to and those which have given the most characteristic results are:

First, its use on the rolling stock and locomotive equipment of the French State railways. The first trial was made on the cross bracing of the guard plates on an American locomotive, whose nuts were previously subject to frequent loosening. The trial lasted a year and was followed by the use of a hundred of these parts, after which the system was adopted in a general manner for this service, the purchasing agent having been required in all recent orders to use check nuts of this type in replacing ordinary check nuts, especially those on the suspension bolts of locomotives, tenders, and cars.

Second, on the road bed. The Metropolitan R. R., Paris, made a preliminary trial of 500 pieces on its fish plate bolts, then several thousands of check nuts were tried on difficult points. Finally the company adopted this nut for general use on all fish plates, track equipment, and the leverage systems of the electric signals. It seems certain that this type of check nut meets all the conditions of the problem which has just been described. That is, it locks the nuts by a simple and inexpensive method which is able to adapt itself to any bolt already in place, is easy to apply or remove, allows the amount of tightening to be easily regulated, and takes up the play of the parts concerned, giving, finally, entire security.

FRICTION AND LUBRICATION.

The Mechanical Engineer, September 1, 1906.

Probably the most important and complete series of experiments on the friction of journals and pivot bearings yet undertaken, was carried out by the late Mr. Beauchamp Tower, for a Research Committee of the British Institution of Mechanical Engineers. In carrying out the experiments, as the result of an accidental discovery, an attempt was made to measure the pressure at different points of the bearing. A hole had been drilled through the cap and brass for an ordinary lubricator, when, on restarting the machine, oil was found to rise through the hole, flowing over the top of the cap. The hole was then stopped with a wooden plug, but this was gradually forced out on account of the great pressure to which the oil was subjected, and which on screwing a pressure gage into the hole was found to exceed 200 pounds per square inch, although the mean load on the journal was only 100 pounds per square inch. Mr. Tower proved by this and subsequent experiments that the brass was actually floating on the film of oil existing between the shafting and the bearing. By drilling a number of small holes at different points in the brass, and connecting each one of them during the test to a pressure gage, Mr. Tower was able to obtain a diagram showing the distribution of pressure upon the bearing. It appears that the pressure is greatest a little to the off-side and at the middle of the length of the bearing, gradually falling to zero at each edge. The total upward pressure

was found to be practically the same as the total load on the bearing, again showing that the whole of the weight was borne by the film of oil. Any arrangement which would permit the film to escape was found to result in undue heating, and the bearing would finally seize at a very moderate load. The oil bath lubrication was found to be the most perfect system of lubrication possible. In the table below the results obtained by Mr. Tower are specified for three different methods of oiling.

	Actual Load in pounds per square inch.	Coefficient of Friction.	Relative Friction.
Oil bath	263	0.00139	1.00
Syphon lubricator	252	0.00980	7.06
Pad under journal....	272	0.00900	6.48

With the needle lubricator and a straight groove in the middle of the brass for distributing the oil, the bearing would not run cool when loaded with only 100 pounds per square inch, and no oil would pass down from the lubricator. The groove, in fact, was found to be a most effective method of collecting and removing the film of oil. In the next place, the arrangement of grooves usual in locomotive axle boxes was adopted, the oil being introduced through two holes, one near each end and each communicating with a curved groove. This bearing refused to take the oil, and could not be made to run cool, and after several trials the best results which could be obtained led to the seizure of the brass under a load of only 200 pounds per square inch. These experiments proved clearly the futility of attempting to introduce the lubricant at that part of the bearing. A pad placed in a box full of oil was therefore fixed below the journal, so as to be always in contact with it when revolving. A pressure of 550 pounds per square inch could then be carried without seizing, or very nearly the same load as in the case of oil-bath lubrication.

Results of Tower's Experiments.

One important result was to show that friction is nearly constant under all loads within ordinary limits, and that it does not increase in direct proportion to the load according to the ordinary laws of friction. This is indicated by the result of the experiments recorded below.

Journal, 4 inches diameter, 6 inches long. Brass, 4 inches wide. Speed, 300 revolutions = 314 feet per minute. Temperature, 90 degrees F.

BATH OF LARD OIL.

Pressure in pounds per sq. inch of bearing $p = \dfrac{W}{d \times l}$

Pressure per sq. in.	Coefficient of Friction $= \mu$	Product $p \times \mu$
520	0.0013	0.676
415	0.0016	0.664
310	0.0022	0.682
205	0.0031	0.635
153	0.0041	0.627
100	0.0067	0.670

BATH OF OLIVE OIL.

Pressure in pounds per sq. inch of bearing $p = \dfrac{W}{d \times l}$

Pressure per sq. in.	Coefficient of Friction $= \mu$	Product $p \times \mu$
520	0.0013	0.676
468	0.0015	0.702
415	0.0017	0.705
363	0.0019	0.689
310	0.0021	0.651
258	0.0025	0.645
205	0.0030	0.615
153	0.0044	0.673
100	0.0069	0.690

The coefficient of friction with bath lubrication varies inversely as the pressure, or, in other words, the friction of the bearing is altogether independent of the pressure upon it; the first law of friction should therefore read: "Temperature and velocity remaining constant, the friction coefficient is proportional to the nominal pressure, and the work done against friction is independent of the load, provided this does not exceed from 400 pounds to 600 pounds per square inch." From this it follows that the work done in overcoming friction is independent of the load upon a machine, and that there is no appreciable increase in the loss due to friction from no load to full load. Under a load of 300 pounds per square inch and with a surface speed of 300 feet per minute, Mr. Tower found the coefficient of friction to be 0.0016 for oil-bath lubrication, and 0.0097 for a pad.

In the next place it was found that the coefficient of friction is inversely proportional to the temperature, other conditions remaining the same, as shown below.

Variation of Friction with Temperature.—Journal, 4 inches diameter, 6 inches long. Brass, 4 inches wide. Speed, 300 revolutions = 314 feet per minute. Load, 100 pounds per square inch on nominal area.

BATH OF LARD OIL.

Deg F.	Temperature (Degs. F. − 32) = t.	Coefficient of Friction = μ.	Product $t \times \mu$.
120	88	0.0044	0.387
110	78	0.0050	0.390
100	68	0.0058	0.394
90	58	0.0069	0.400
80	48	0.0083	0.398
70	38	0.0103	0.391
60	28	0.0130	0.364

The second law of friction should therefore be stated: "Nominal pressure and velocity remaining constant, the coefficient and therefore the work done against friction, is inversely proportional to the temperature of the bearing."

This has also been very neatly demonstrated by a recent experimenter, Mr. Dettmar, whose machine is electrically driven, and therefore the consumption of current could be very accurately measured during a five hours' run at constant speed and voltage. As load and velocity remain constant throughout the test, a decrease in the loss due to friction could only occur with a diminution in the coefficient. The current fell off exactly in the same ratio as the temperature increased, and as soon as the temperature became constant the consumption of current also remained constant.

The results of Tower's experiments seem to indicate that friction increases with the velocity, although not nearly in proportion to the square of the velocity as observed by Dettmar. As the result of the more exact determination possible with his machine, Dettmar found that friction increases very nearly as the 1.5th power of the velocity.

The mean values of the coefficient of friction for different lubricants, and with different methods of lubrication as obtained by Mr. Tower, are given in the following table:

Journal, 4 inches diameter, 6 inches long. Brass, 4 inches wide. Speed, 300 revolutions = 314 feet per minute. Temperature, 90 degrees F.

Lubricant.	Coefficient of Friction.	Max. Safe Pressure in pounds per sq. inch on Nominal Area.
Olive oil	0.00172	520
Lard oil	0.00172	570
Sperm oil	0.00208	570
Mineral oil	0.00176	625
Mineral grease	0.00233	625

* * *

An important announcement has been made regarding the age limit of employes of the Pennsylvania Railroad. Some years ago under the management of A. J. Cassatt a pension system was adopted and the age limit at which men could enter the employ of the company was fixed at 35 years. The newly elected president, Mr. James McCrea, has decided to change the age limit from 35 to 40 years and will ask the directors to approve of the change at the annual meeting in March. The age limit of 35 years was copied by many other railroads and large corporations throughout the country, but during the past few years it has been found a mistake and a number of corporations have changed to the 40-year limit, including the Boston & Maine, Chicago, Milwaukee & St. Paul, and others.

* * *

An advertisement in a contemporary reads: "General Engineer and Electrician, with a thorough knowledge of steam engines and boilers, gas, oil and petrol engines, motor car, and launch construction, electric light and motor installations, wiring, repairing and testing, printing and bookbinding machinery, wood working machines, refrigerating plant, etc., also a very fair patternmaker and draftsman, inventor and patentee, desires situation."

ON THE ART OF CUTTING METALS.—3.*

FRED. W TAYLOR.

PROPER SHAPE FOR STANDARD SHOP TOOLS.

As stated in the beginning of this paper, our principal object in carrying on the investigation has been to obtain the knowledge required in fixing daily a definite task, with a time limit, for each machinist. It is evident that this involves the use of standard cutting tools throughout the shop which are in all respects exact duplicates of one another.

In our practical experience in managing shops we have found it no easy matter to maintain at all times an ample supply of cutting tools ready for immediate use by each machinist, treated and ground so as to be uniform in quality and shape; and the greater the variety in the shape and size of the tools, the greater becomes the difficulty of keeping always ready a sufficient supply of uniform tools. Our whole experience, therefore, points to the necessity of adopting as small a number of standard shapes and sizes of tools as practicable. It is far better for a machine shop to err upon the side of having too little variety in the shape of its tools rather than on that of having too many shapes.

Standard Tools Illustrated.

In the cuts Figs. 10 to 21, inclusive, are illustrated the shapes of the standard tools which we have adopted, and in justification of our selection the writer would state that these tools have been in practical use in several shops both large and small through a term of years, and are giving general, all-round satisfaction. It is a matter of interest also to note that in several instances changes were introduced in the design of these tools at the request of some one foreman or superintendent, and after a trial on a large scale in the shop of the suggested improvements, the standards as illustrated above were again returned to. These shapes may be said, therefore, to have stood the test of extended practical use on a great variety of work.

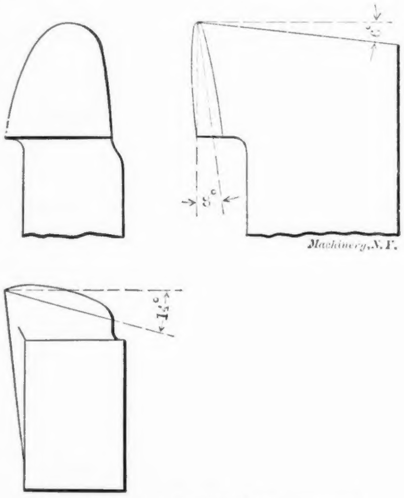


Fig. 10. Tool for Cutting Cast Iron and Hard Steel.

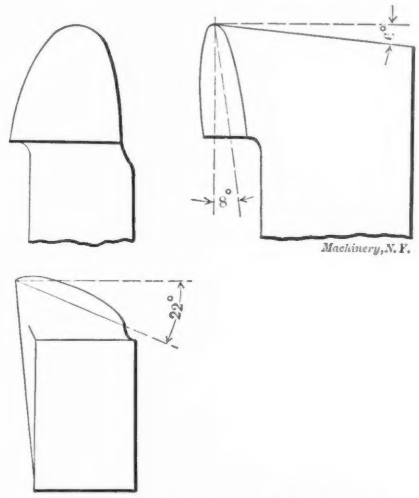


Fig. 11. Tool for Cutting Medium and Soft Steel.

Conflict between the Objects to be Attained in Cutting Metal.

Our standard tools may be said to represent a compromise in which each one of the following elements has received most careful consideration, and has had its due influence in the design of the tool; and it can also be said that hardly a single element in the tools is such as would be adopted if no other element required consideration. The following, broadly speaking, are the four objects to be kept in mind in the design of a standard tool:

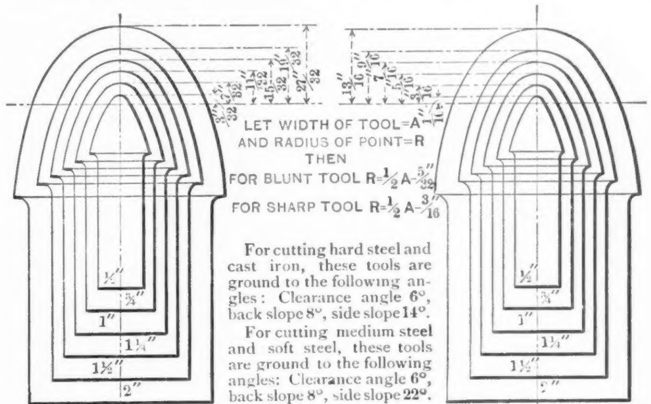
a. The necessity of leaving the forging or casting to be cut with a true and sufficiently smooth surface;

b. The removal of the metal in the shortest time;

c. The adoption of that shape of tool which shall do the largest amount of work with the minimum combined cost of grinding, forging and tool steel;

d. The ready adaptability to a large variety of work.

As we go further into this subject, the nature of the conflict between these four objects and of the sacrifice which each element is called upon to make by one of the others will become apparent. Generally speaking, we have been obliged to adopt as our standard shape a tool which can be run at only about, say, five-eighths of the cutting speed which our knowledge of the art and our experiments show us could be obtained through another tool of entirely different shape, if no other element than that of cutting speed required consideration. We have been obliged to sacrifice cutting speed to securing smaller liability to chatter; a truer finish; a greater all-round convenience for the operator in using the tool, and a comparatively cheaper dressing and grinding. The most important of the above considerations, however, is the freedom from chatter.



Figs. 12 and 13. Outline of Cutting Edge of Standard Round-nosed Tools.

On the other hand we have been obliged to adopt a rather more elaborate and expensive method of dressing the tools than is usual, in order to provide a shape of tool which allows it to be ground a great many times without redressing, and also in order to make a single Taylor-White heat treatment of the tool last longer than it otherwise would. And again, the shape of the curve of the cutting edge of the tool which we have adopted—first, to insure against chatter, and second, for all-round adaptability in the lathe—calls for much more expense and care in the grinding than would be necessary if a more simple shape were used. This necessitates in a shop either a specially trained man to grind the tool by hand to the required templets and angles, or preferably the use of an automatic tool grinder.

Relative Importance of the Elements Affecting the Cutting Speed.

The cutting speed of a tool is directly dependent upon the following elements. The order in which the elements are given indicates their relative effect in modifying the cutting

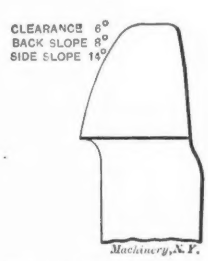


Fig. 14. Standard Tool for Wide Feeds.

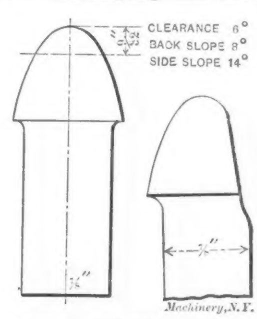


Fig. 15. Tool used in most of the Taylor Experiments.

speed, and in order to compare them, we have written in each case figures which represent, broadly speaking, the ratio between the lower and higher limits of speed as affected by each element.

A. The quality of the metal which is to be cut, *i.e.*, its hardness or other qualities which affect the cutting speed. Pro-

* Abstract of paper presented before the American Society of Mechanical Engineers, December, 1906.

portion is as 1 in the case of semi-hardened steel or chilled iron to 100 in the case of very soft low-carbon steel.

B. The chemical composition of the steel from which the tool is made, and the heat treatment of the tool. Proportion is as 1 in tools made from tempered carbon steel to 7 in the best high-speed tools.

C. The thickness of the shaving; or, the thickness of the spiral strip or band of metal which is to be removed by the tool, measured while the metal retains its original density; not the thickness of the actual shaving, the metal of which has become partly disintegrated. Proportion is as 1 with thickness of shaving 3-16 of an inch to 3½ with thickness of shaving 1-64 of an inch.

D. The shape or contour of the cutting edge of the tool, chiefly because of the effect which it has upon the thickness of the shaving. Proportion is as 1 in a thread tool to 6 in a broad-nosed cutting tool.

E. Whether a copious stream of water or other cooling medium is used on the tool. Proportion is as 1 for tool running dry to 1.41 for tool cooled by a copious stream of water.

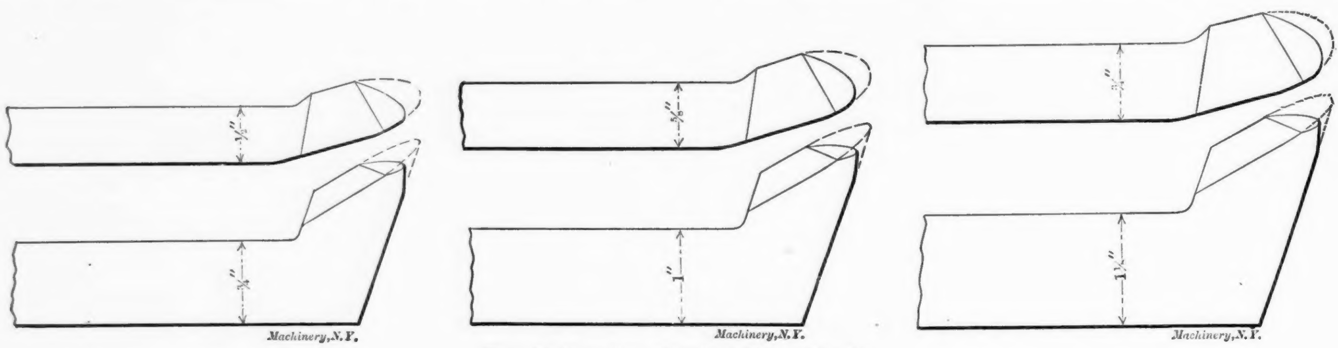
F. The depth of the cut; or, one-half of the amount by which the forging or casting is being reduced in diameter in turning. Proportion is as 1 with ½ inch depth of cut to 1.36 with ⅛ inch depth of cut.

G. The duration of the cut; *i.e.*, the time which a tool must last under pressure of the shaving without being reground. Proportion is as 1 when tool is to be ground every 1½ hour to 1.207 when tool is to be ground every 20 minutes.

H. The lip and clearance angles of the tool. Proportion is as 1 with lip angle of 68 degrees to 1.023 with lip angle of 61 degrees.

J. The elasticity of the work and of the tool on account of producing chatter. Proportion is as 1 with tool chattering to 1.15 with tool running smoothly.

The quality of the metal which is to be cut is, generally speaking, beyond the control of those who are in charge of the machine shop, and, in fact, in most cases the choice of the hardness of metals to be used in forgings or castings will hinge upon other considerations which are of greater importance than the cost of machining them. The chemical composition of the steel from which the tool is made and the heat treatment of the tool will, of course, receive the most careful consideration in the adoption of a standard tool. No shop, however, can now afford to use other than the "high-speed tools," and there are so many makes of good tool steels, which, after being forced into tools and heated to the melting point according to the Taylor-White process, will run at about the same high cutting speeds, that it is of comparatively small moment which particular make of high-speed steels is adopted.



Figs. 16, 17 and 18. Standard Sizes of Tools.

Advantages of Round-nosed Tools.

With round-nose tools, as the depth of cut becomes more shallow, there is a greater increase in the cutting speed than in the case of tools having straight-line cutting edges, because with a round-nosed tool the thickness of the shaving becomes thinner and thinner as the extreme nose of the tool is approached. In the case of round-nosed tools, therefore, when the depth of the cut is diminished, the cutting speed is increased for two entirely different reasons:

A. Because the chip bears upon a smaller portion of the cutting edge of the tool.

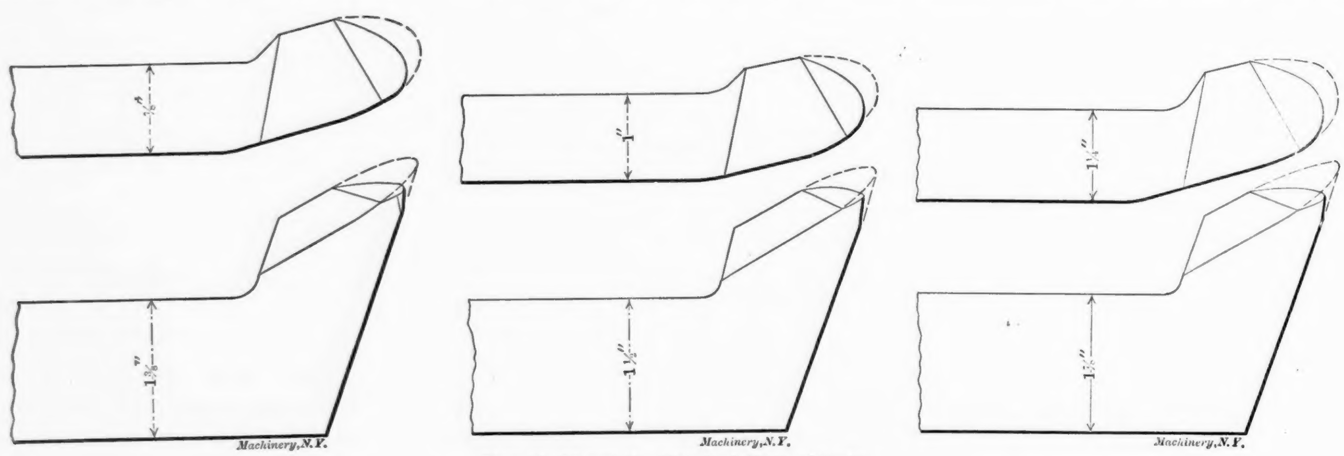
B. Because the average thickness of the chip which is being removed is thinner in the case of round-nosed tools with a shallow depth of cut than it is with the deeper cuts.

Object of having the Cutting Edge of Tools Curved.

A tool whose cutting edge forms a curved line of necessity removes a shaving which varies in its thickness at all parts. The only type of tool which can remove a shaving of uniform thickness is one with a straight-line cutting edge. The object in having the line of the cutting edge of a roughing tool curved as that part of the cutting edge which does the finishing is approached, is to thin down the shaving at this point to such an extent as will insure the finishing part of the tool remaining sharp and uninjured even though the main portion of the cutting edge may have been ruined through overheating or from some other cause.

Advantages and Disadvantages of Broad-nosed Tools.

Upon appreciating the increase in the cutting speed obtained through thinning down the shaving, as shown in our experiments with straight cutting edge tools, the tools shown in Figs. 22, 23 and 25 were made, and used on roughing work for years in the axle lathes of the Midvale Steel Company. The gain in cutting speed of these standard broad-nosed tools over our standard round-nosed tools, shown in Figs. 14 and 15, is in the ratio of 1.30 : 1. This general shape of tool continues to be extensively used, but it is subject to the disadvantage that it is likely to cause the work to chatter, and so leave a more or less irregular finish. Were it not for this difficulty, added to the fact that our standard round-nosed tool has a greater all-round adaptability and convenience, the tools illustrated in Figs. 22, 23, and 25, would undoubtedly be the proper shapes for shop standards.



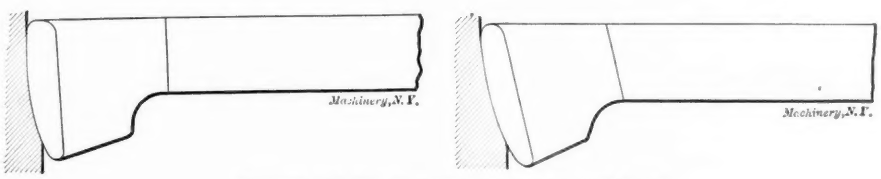
Figs. 19, 20 and 21. Standard Sizes of Tools.

Small Radius of Curvature Tends to Lessen Chatter.

Since the thickness of the shaving is uniform with straight edge tools, it is evident that the period of high pressure will arrive at all points along the cutting edge of this tool at the same instant and will be followed an instant later by a corresponding period of low pressure; and that when these periods of maximum and minimum pressure approximately correspond to, or synchronize with, the natural periods of vibration either in the forging, the tool, the tool support, or in any part of the driving mechanism of the machine, there will be a resultant chatter in the work. On the other hand, in the case of tools with curved cutting edges, the thickness of the shaving varies at all points along the cutting edge. From this fact, coupled with Dr. Nicolson's experiments, it is obvious that when the highest pressure corrresponding to one thickness of shaving along a curved cutting edge is reached, the lowest pressure which corresponds to another thickness of shaving at another part of the cutting edge is likely to occur at about the same time, and that therefore variations up and down in pressure at different parts of the curve will balance or compensate one for the other. It is evident, moreover, that at no one period of time can the wave of high pressure or low pressure extend along the whole length of the curved cutting edge.

tool could be completely resharpened. On the other hand, it is clear that if the tool were to be ground on its clearance flank alone, a much larger amount of metal must be ground off before entirely restoring the line of the cutting edge. This shows that for economy tools must be ground both upon their lip and clearance surfaces.

In many shops the practice still prevails of merely cutting a piece of the proper length from a bar of steel and grinding the curve or outline of the cutting edge at the same level as the top of the tool, as shown in Figs. 24 and 26. This entails the minimum cost for dressing, but makes the grinding very expensive, since the lip surface must be ground down into the solid bar of steel, thus bringing the corner of the grindstone or emery wheel at once into action and keeping it continually at work. This quickly rounds over the corner of the stone, and necessitates its frequent truing up, thus increasing the cost of grinding, both owing to the waste of the stone and the time required to keep it in order; and it also leaves the face of the grindstone high in the center most of the time, and unfit for accurate work. As far as possible, then, the shape of standard cutting tools should be such as to call for little or no grinding in which the corner of the emery wheel does much work. With the type of tool illustrated in Fig. 26, also, comparatively few grindings will make



Figs. 22 and 23. Examples of Broad-nosed Tools.

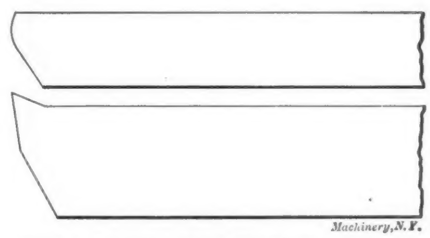


Fig. 24. Common, but Objectionable, Way of Dressing Tools.

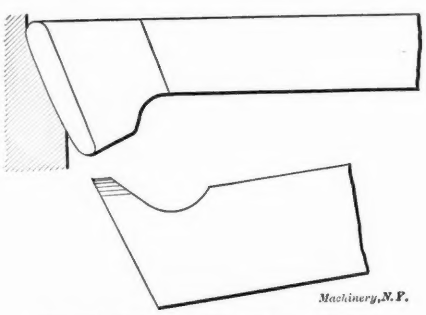
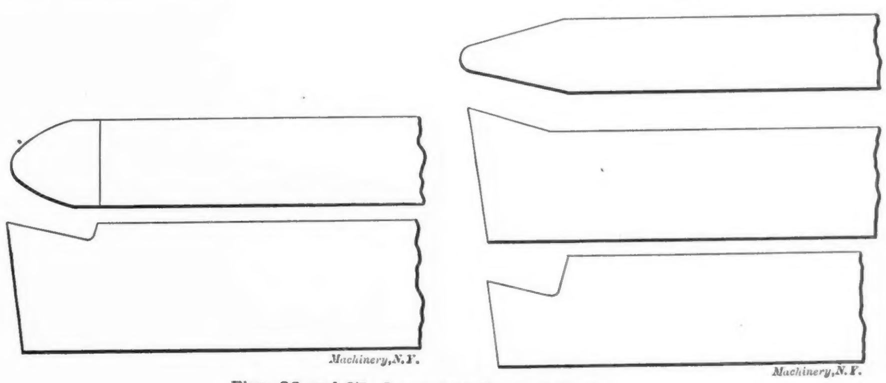


Fig. 25. Example of Broad-nosed Tool.



Figs. 26 and 27. Incorrectly Dressed Tools.

Combined Cost of Forging and Grinding Considered.

In adopting the general shape or conformation of a tool (we do not here refer to the curve of the cutting edge), the most important consideration is that of selecting a shape with which the largest amount of work can be done for the smallest *combined cost of forging or dressing and grinding*, and the dressing is much the more expensive of these two operations. It is, therefore, of paramount importance to so design the tool that it can be ground:

a. The greatest number of times with a single dressing;

b. With the smallest cost each time it is ground.

Modern high-speed tools when run at economical speeds are injured much more upon the lip surface than upon the clearance flank. Therefore, at each grinding a larger amount of metal must be ground away from the lip surface than from the clearance flank; and yet in many cases the clearance flank will be more or less injured (rubbed or scraped away) below the cutting edge, and it therefore becomes necessary, for maximum economy, in practical use, to grind roughing tools both upon their lip and their clearance surfaces.

In Fig. 8 (February issue) is shown the typical wear on a tool which has been run at an economical speed. This tool has been guttered out on the lip surface and also slightly rubbed away on its clearance flank. It is evident that if it were ground on the lip surface alone a considerable amount of the metal would be wasted before the cutting edge of the

a deep depression in the body of the tool, as shown in the lower view of Fig. 27, and this depression will, of course, be greater the steeper the back slope of the lip surface of the tool.

To avoid these difficulties, perhaps the larger number of well-managed machine shops in this country have adopted a type for dressing their tools in which the front of the tool is forged slightly above the level of the tool, as shown in the lower view of Fig. 24 and in the middle view of Fig. 27. This type of tool dressing is done in each of the following ways:

A. By laying the tool on its side and slightly flattening its nose by striking it with a sledge, thus narrowing the nose of the tool and at the same time raising it slightly above the level of the top of the tool.

B. By cutting off the clearance flank of the tool at a larger angle than is demanded for clearance, and then slightly turning up the cutting edge of the tool through sledging upon the clearance flank while the tool is held upon the edge of the anvil with its shank below the level of the anvil.

The objection to both of these types is that the tools require redressing after being ground a comparatively small number of times, and that when redressed in many cases the whole nose of the tool is cut off and thrown away. This waste of metal, however, is of much less consequence than the frequency of dressing. With the first of these types of tool dressing the tendency is to make the nose of the tool too thin, that is, having too small a radius of curvature, and thus to furnish a tool which must be run at too slow a cutting speed.

HOBS AND DIE TAPS.

ERIK OBERG.

Hob taps are, as a rule, only intended for final finishing or sizing of the thread in dies. For this reason their construction differs widely from that of ordinary hand taps. They are not supposed to have any actual cutting to do, being merely used for burring a thread already cut with ordinary taps. Straight hob taps are not relieved at all whether on the top or in the angle of the parallel portion of the thread. Two or at most three threads, however, are chamfered at the point of the tap, and these chamfered threads are relieved on the top of the thread the same as ordinary hand taps. A taper hob, of course, should be slightly relieved on the top as well as in the angle of the thread. The flutes of a hob tap constitute the essential difference of this tap from the hand tap. The number of the flutes is greater and the cutters used are usually regular angular cutters of 50 degrees inclusive angle, 25 degrees on each side. They should have a very slight round joining the angular sides. The dimensions of ordinary hob taps are made the same as for regular hand taps. These were given in the supplement to the January issue of MACHINERY and the only additional information, therefore, is the number of the flutes. These will be found from the table of Sellers hobs in the supplement, the number of flutes being made the same for these latter hobs as for regular ones.

The Sellers' hobs are a special kind of hob taps differing from the ordinary hob tap therein that they are provided with a guide at a point of the thread. The diameter of this guide or pilot is given in the table in the supplement according to the ordinary method in practice. The other dimensions are given approximately according to formulas below in which:

D = diameter of hob,
A = total length of the hob,
B = length of the pilot,
C = length of the thread,
E = length of the shank,
G = the size of the square, and
H = the length of the square.

Formulas for hobs up to 2 inches in diameter are:

$$A = 5\tfrac{3}{8}D + 3\tfrac{3}{8},$$

$$B = \frac{5D}{2} + \tfrac{5}{8},$$

$$C = \frac{5D}{2} + \tfrac{5}{8},$$

$$E = \frac{3D + 17}{8},$$

$$G = \tfrac{3}{4} \times \text{diameter of shank},$$

$$H = \frac{3D + 5}{8}.$$

For sizes of Sellers' hobs, 2 inches in diameter and more, use the formulas:

$$A = 3\tfrac{3}{8}D + 7\tfrac{3}{8},$$

$$B = \frac{3D}{2} + 2\tfrac{5}{8},$$

$$C = \frac{3D}{2} + 2\tfrac{5}{8},$$

$$E = \frac{3D + 17}{8},$$

$$G = \tfrac{3}{4} \times \text{diameter of shank},$$

$$H = \frac{3D + 5}{8}.$$

The diameter of the shank should be made about 1-64th smaller than the diameter of the root of the thread. The guide or pilot should always be hardened and ground.

Die taps are used for cutting the thread in the die in one single operation from the blank and are supposed to be followed by the hob tap. The die tap is provided with a long chamfer portion and a short straight or parallel thread. If to be followed by a hob tap, the parallel portion should be slightly under the standard size so as to leave enough metal for the hob tap to remove to insure the correct size of the die. This difference in size should be not only on the top of the thread but in the angle of the thread as well, so that any inaccuracy in the lead of the thread may be taken care of. On the other hand it must be remembered that the difference must be very slight, as the hob cannot remove very much stock, having a very short chamfer and very small chip room for the stock removed. If this is not taken into consideration the dies may be injured in the sizing operation. It may not be out of the way to point out that one should never try to cut the full thread in the die with a hob as this is purely impossible if any satisfactory results whatever are expected. It probably seems unnecessary to mention, but the writer knows of cases where persons, supposedly well-informed as to the use of tools, have bought hob taps for the purpose of cutting dies with these taps in one operation, and after having met with failure in accomplishing this, have complained that the tools supplied were not satisfactory.

Returning to die taps we may say that they are very similar to machine taps and are made almost exactly in the same way. The flutes are cut with the same fluting cutters as used for machine taps. The die taps are relieved both on the top of the thread and in the angle of the thread on the chamfered portion, and they are threaded on a taper for a short distance from the point of the tap the same as machine taps. On the end of the die tap a straight pilot may be provided with advantage. This will help in guiding the tap straight when starting the thread. Some manufacturers do not provide their taps with a straight pilot on the end, simply chamfering it all the way down to the point, but make the diameter of point below the root diameter of the thread for a distance equivalent to the length of the guide. This, of course, serves no other purpose than to aid in facilitating the point of the tap to easily enter the hole in the die blank and does in no way guide or start the tap straight. When these taps are to be used for threading dies which have already been provided with clearance holes, they should be fluted with somewhat narrower flutes than otherwise, leaving the lands fairly wide, and preferably be given a greater number of flutes than normally. This will permit the tap to pass through the die without deviating from its true course. In the supplement will be found a table giving complete dimensions for these taps. The dimensions are figured from the formulas below. In these formulas:

D = diameter of the thread,
A = total length of die tap,
B = length of the thread,
C = length of the shank,
E = length of the straight thread,
F = length of the pilot,
G = size of the square, and
H = length of the square.

For diameters below $2\tfrac{1}{2}$ inches the following formulas are used:

$$A = 5\tfrac{3}{4}D + 3\tfrac{3}{4},$$
$$B = 4\tfrac{1}{4}D + 1\tfrac{3}{4},$$
$$C = 1\tfrac{1}{2}D + 2,$$
$$E = D,$$
$$F = \sqrt{D} - \tfrac{1}{8},$$
$$G = \tfrac{3}{4} \times \text{the diameter of shank},$$
$$H = \tfrac{5}{8}D + 7/16.$$

For sizes $2\tfrac{1}{2}$ inches and larger the following formulas are used:

$$A = 3\tfrac{1}{2}D + 9\tfrac{3}{8},$$
$$B = 2D + 7\tfrac{3}{8},$$
$$C = 1\tfrac{1}{2}D + 2,$$
$$E = D,$$
$$F = \sqrt{D} - \tfrac{1}{8},$$
$$G = \tfrac{3}{4} \times \text{diameter of the shank},$$
$$H = \tfrac{1}{8}D + 1\tfrac{11}{16}.$$

It must be plainly understood that the formulas given are for guidance only, and that no hard and fast rule could be made in regard to the dimensions. Formulas are given for so insignificant a dimension as the length of the squared portion of the shank only in order to facilitate a systematic arrangement of the values in the tables in the supplement.

GRINDING CRANKSHAFTS—FOUNDATIONS FOR MACHINE TOOLS.

A recent visit to the shops of the Norton Grinding Co., Worcester, Mass., discovered that concern in the same condition as are practically all the American machine tool builders at the present time—busy. The foundations for an extensive addition to the present shop, nearly doubling its capacity, have been laid, and the building will be erected in the spring. Not content with building grinding machines alone, they have equipped a special department for grinding automobile crankshafts, which, we infer, is not only profitable in itself but is an excellent educator in demonstrating the possibilities of the grinding machine in a field comparatively new. The accompanying Fig. 1 shows this department and will give an idea of the extent of the work now being carried on. About 1,000 crankshafts, mostly of 4-throw, but some of 6-throw type, as will be noted in the foreground, were in this department at the time the photograph was taken, and the weekly production of finished pieces was 125. A considerable number of the leading automobile builders have found that the making of an accurate crankshaft is such a difficult and costly proposition that they have very gladly given over to the Norton Grinding Co. contracts for finishing crankshafts from drop forgings, under guarantee to come within certain close limits for length of throw, parallelism of crankpins, alignment of shaft bearings, general finish, etc. The grinding machine is a tool capable of the most accurate work as all of us very well know who are at all familiar with general machine shop practice, but that it is also a machine capable of removing large amounts of stock in a very short time under conditions that make the operation of ordinary cutting tools very difficult, is not so well-known as it should be.

The crankshafts come to the shop in the rough drop forged form. They are first centered and then are rough ground. It is not seldom that it happens that the amount of the metal that must be removed is such as to mean a reduction in diameter of 3/16 or even ¼ inch. The work is not traversed when grinding pins and bearings; the wheel attacks the material, the full width of the crankpin, rough grinding it in from four to five minutes. After being rough ground the crankshafts are taken to a lathe and the fillets are rough turned with a lathe tool, as it has not been found economical or good practice to attempt to grind the fillets on the grinding machine. After the fillets are rough turned the cranks are returned to the grinding machine for finish grinding, after which the fillets are finish turned again on the lathe. The inspection is very rigid and in the case when long shafts are tested it has been found to be necessary to test in a vertical position on account of the slight deflection of the shaft due to its own weight when suspended at the two outermost bearings. An interesting fact developed in this work where so many different designs of crankshafts are being machined, is that those on which it is unnecessary to break the scale on the crank webs, give by far the least trouble in getting accurate alignment, and where the webs are inclined at an obtuse angle to the crankpin the conditions are still more favorable.

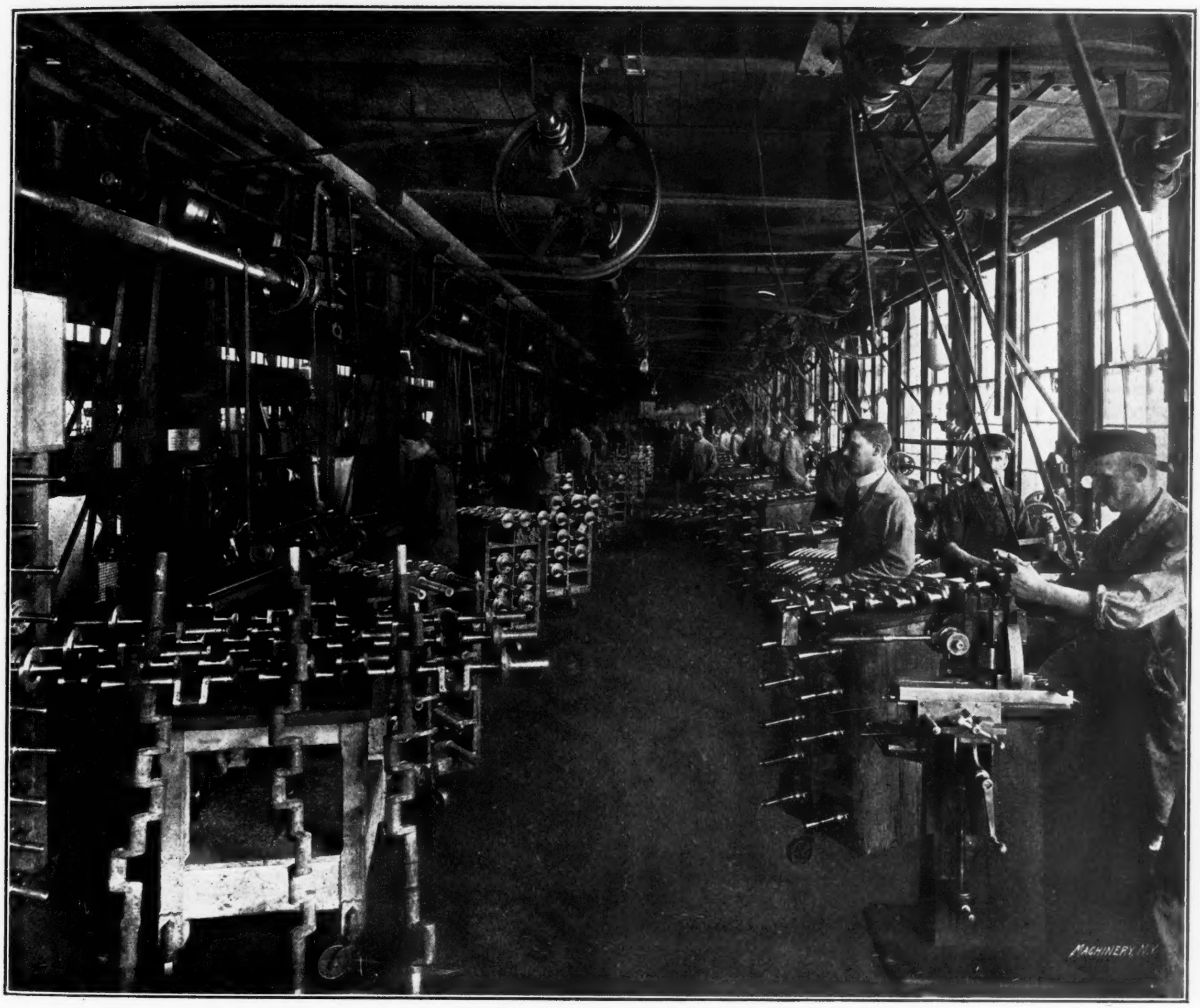


Fig. 1. Automobile Crankshaft Grinding Department, Norton Grinding Co.

That this department is not only profitable as a producer of finished crankshafts, but is an effective object lesson in showing manufacturers what the actual possibilities of the grinding machine really are, is obvious to anyone who has visited the shop, seen the work and learned what the cost of producing finished crankshafts is. We will not give here the figures, but the cost is a sum so small as to appear ridiculous to one who has only followed the older methods. While some of the other finished work that is kept in the shop for

show purposes is of much interest, as for example, ground locomotive piston rods, rolls for flour mills and rolling mills, huge sections of steel pipe, ground and unground to show the rough turning preparatory to grinding, and other large work guaranteed to be parallel, within a limit of 0.001 inch in a length of 8 or 10 feet, the crankshaft grinding department is in itself a live embodiment of possibilities that the others cannot so effectively show.

At the time of the writer's visit Mr. Norton was putting down foundations, of much practical value, for a large planer and milling machine, two views of which are shown in Figs. 3 and 4. The interesting features of this foundation are the method in which it was built up and the adjusting plate used under the planer feet for getting an absolutely level bearing at all points. While adjusting sole plates for planers are by no means new they have generally been made quite inadequate for the purpose required. This plate shown in Fig. 2 is composed of three parts. The base is a heavy casting, truss ribbed on the bottom, and tapped at the four corners for the leveling screws; it is made with two parallel ledges at opposite sides in which are tapped holes for the two adjusting screws. In the center of the base is a boss with an inclined top on which is laid a wedge, this being located directly between the two adjusting screws. On top of the wedge is the actual sole plate so far as the machine tool is concerned. Both upper and lower surfaces of the top plate, and the upper side of the wedge are planed. A spline and groove are also planed in the sole plate and wedge for guidance.

Fig. 3 shows a planer foundation partly constructed, on which eight of these adjusting plates are set preparatory to filling in the foundation with concrete, flush with the top of

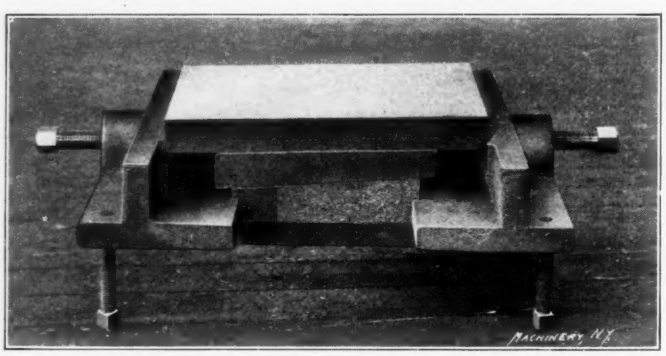


Fig. 2. Adjusting Plate for Machine Tool Foundations.

the sole plate. The foundation is of solid concrete 5 feet deep, and is one monolithic piece the entire length. It is first built up to within 8 or 10 inches of the floor and then the adjusting plates are set and each leveled by the four leveling screws. By adjusting these screws the top plates are all made level and all are brought exactly into the same plane; this condition is carefully tested with a 15-foot Brown & Sharpe straightedge. Tissue paper is used under the straightedge to test the plates at all points, crosswise, lengthwise and diagonally.

After being leveled in this manner the foundation is filled in to the floor level as shown in Fig. 4. This view shows a completed foundation made in the above manner for a Beaman & Smith milling machine, and includes twelve of the adjusting plates. The adjusting screws are barely visible in the halftone but the pockets left for a wrench are plainly shown. After the machine is in place and leveled, the pockets are covered with small castings which keep out chips and dirt. These adjusting plates are intended not only for obtaining correct original alignment of the machine, but are also to be used whenever it is found that there is the slightest inaccuracy in the work produced. It is entirely possible with these adjusting plates to spring a milling machine or planer bed so as to make it plane or mill true at any time, whether the machine be new or considerably worn. With planers set on such a foundation it is easy to turn out work that is dead straight and on which there will be needed the minimum of scraping and other corrective work.

In this connection it is of interest to note that Mr. Norton has found it unnecessary to bolt a planer to the foundation at all. It is the practice to drill one or more pairs of the adjusting plates and put in a half-inch pin at either side on one or more pairs of the planer feet to prevent the planer from sliding endwise, but it has been found in those cases where the pins did not touch the planer, when first put down, that the planer has never moved enough to cause them to touch. Inasmuch as it has been customary to bolt planers down this is valuable experience. Mr. Norton believes that

Fig. 3. Concrete Block Foundations for Planer, with Adjusting Plates in Position and ready for the Concrete Filling.

a modern planer that is heavy enough to be of real service cannot be moved by any reversal of the table, and that the foundation should be one that *supports*, but not one necessarily to hold a machine tool down. The company is putting down all their foundations on this plan, and although the original investment is considerable they believe that it is warranted on account of saving a large percentage of the scraping ordinarily necessary. To illustrate, they have a 36 x 36 x 18-foot planer placed on such a foundation which was leveled as described. After the table had been planed after a year's use, tests made with the 15-foot Brown & Sharpe straightedge on the table with tissue paper under either end and under the center showed that the table was accurate at whatever position along the bed of the planer it was placed. Mr. Norton suggests that, if any of our readers have doubts about this being a not unusual condition, let them try it on an average planer as set up in most of our manufacturing plants and find what the results are. In all probability they will be greatly surprised at the inaccuracy found, and the differences at various points on the bed. By making the foundation in one solid piece of concrete and using the leveling arrangement described, it is a matter of everyday occurrence to plane work to a degree of accuracy that was

Fig. 4. Completed Foundation, with Adjusting Plates for Beaman & Smith Milling Machine.

formerly considered entirely impossible. Inasmuch as the accuracy of planed surfaces is so vital to the success of the grinding machine, we may well believe that Mr. Norton's machine foundations represent another step in the advancement of machine tool practice.

VISIT TO THE EXPOSITION OF SAFETY APPLIANCES.

When the writer entered the space allotted to the safety appliance exposition in the Museum of Natural History, the first thing that struck him was a young man who was anxious to explain the merits of the Monarch engine stop. The young man was interesting and the listener was interested, so they went together to the booth where the apparatus was installed and examined the system. While the general principle of the device was familiar enough, a number of little incidental safeguards were brought out in the demonstration, all tending to show how much thought and care had been given to making its operation as sure as anything mortal can be. For instance, the automatic closing device is attached to the same valve the engineer has to use every time he starts and stops the engine, and is thus fairly assured to be in good working order. A circuit breaker is thrown open to disconnect a

Commemorative Medal Presented to Exhibitors, First International Exposition of Safety Appliances, New York, Jan. 29 to Feb. 12, 1907.

direct-connected generator when it is operating in multiple with others, thus obviating the danger of having the dynamo act as a motor. The various push buttons which may be located around the shop, and the speed limit device which is directly attached to the main shaft, are all connected by a double circuit mechanism in such a way as to require the breaking of three out of four wires to prevent its action. A testing button is provided which throws all the various circuits into series and rings a buzzer when the button is pressed. This buzzer is wound for a higher resistance than the whole of the rest of the circuit so that if it fails to respond, thus indicating that the batteries are too weak to operate the device, they will still be strong enough for two or three days longer. Before he left, the writer felt really sorry that he did not own an engine to which he might apply one of these stop devices. Having said good-bye to the young man and borrowed his pencil, he continued his tour of inspection, carefully refraining, however, owing to lack of time, from being drawn into further conversation with other demonstrators.

There were a number of manufacturers represented whose names are familiar to the readers of MACHINERY. There was a Flather shaper, electrically driven, with all gearing enclosed so as to be out of harm's way. The Safety Emery Wheel Co. of Springfield, Ohio, showed a wheel which had been ruptured by excessive speed, but which had yet held together instead of throwing itself promiscuously around the shop. Another gear-driven and protected machine was a miller shown by the Garvin Machine Co. The Norton Grinding Co. exhibited a stand with steel guard bands surrounding the wheels. The General Electric and Westinghouse Companies showed a large number of photographs, some of them bearing directly and some very remotely on the questions under consideration.

Of the photographic exhibits made by well-known firms, one of the most instructive was that of the Brown & Sharpe Mfg. Co. Guards covering the change gears of lathes in their shops were illustrated together with band saw guards, exhaust arrangements for grinders, washroom and lavatory fittings, etc. One drawing called attention to an important matter in the arrangement of pulleys on the countershaft. It was shown that the space between the pulley and the hanger should be wider than the belt, so that if it runs off the pulley there will be no danger of its being wedged between the pulley and the hanger; the difficulty of removing a belt in this condition has often led to serious accidents. The overhead cone pulley belt shifter with which their shop is fitted was also illustrated.

In that part of the exhibition devoted to models and commercial exhibits were a number of devices ranging from the serious, through the hilarious, to the pathetic. Safety gas burners were shown which would shut off the supply of gas if the light were accidentally or otherwise blown out, respirators, goggles, and face masks for workers in atmospheres charged with dust and in positions of danger from flying fragments; first aid cabinets for the sick and injured; fusible plugs for boilers; lamps which could be turned bottom side up without disturbance of equanimity on the part of the lamp or the person carrying it, and so on. Most of these are of commercial importance and thoroughly practicable. Some of them were in model form and showed crude ideas and inexperience in practical working conditions on the part of the inventor. Verging on the pathetic was the exhibit of a model of a street car fender; it was applied to a little toy car which had been bought at some children's store. The fender part of it had been made painfully and clumsily, evidently by fingers not used to such work, but anxious to express the idea with which the mind of their owner was charged. Sad to say, there was nothing new or original in the device; it was merely the obvious first thought of an inexperienced inventor.

Perhaps the most suggestive part of the whole was the collection of photographs relating to the exhibits in the various "museums of security" in Europe. The institutions at Amsterdam, Vienna, and Berlin, were especially well represented. A wide range of industries is represented in these pictures; safety stagings, brakes, gas engine starting devices, blankets for rock blasting, belt shifting devices, carboy cases, gage glass guards, barrel skids, etc., in great numbers are represented by pictures from full-sized models. In the Berlin exhibit was shown a picture of a universal grinding machine, with an internal attachment at work and an exhauster connected to the rear end of the work spindle, thus drawing the dust back through the spindle and out of the way of the operator. It was interesting to note that the machine was evidently one of those built by the Brown & Sharpe Mfg. Co.

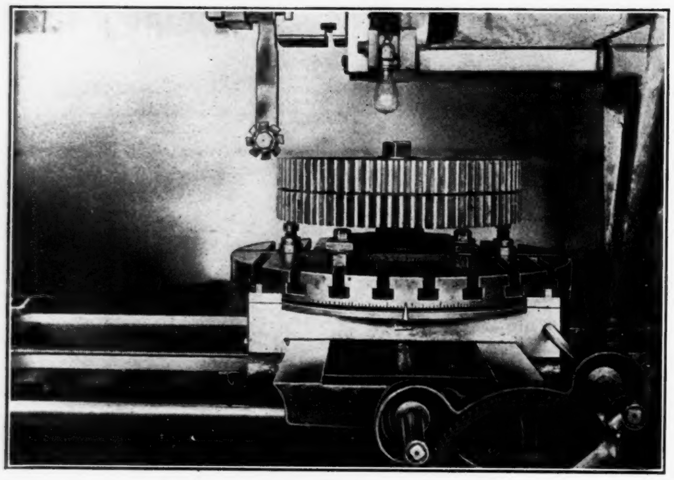
Various devices were shown for making press work less dangerous. One of them, for instance, had the die enclosed by a case with a sliding door in front. This sliding door was attached to the clutch operating lever in such a way that when the clutch was thrown in the door was closed. When the clutch was thrown out and the machine stopped, the door was opened. Another scheme for the same purpose, but permitting somewhat more rapid operation, was one which required the pressure of both hands to start the press going, one hand being applied to a lever on one side of the machine and the other hand at the opposite side. This also made it certain that no damage could be done to the fingers of the operator. Of course, any such device as this in some degree lessens the productive capacity of the machine at the same time it increases the safety of its operation. The owner of much a machine will, in applying these various arrangements, strike a balance between volume of production and safety of operation. The point at which he will draw the line between the practicable and the impracticable will be determined by the fierceness of the competition he has to meet, on one hand, and his humanitarian instincts on the other; the line thus drawn should serve as a reliable index of the progress, both of society and of the individual.

The fact that "museums of security" are recognized and permanent institutions in Europe, and that it has been possible to hold even a temporary exhibit of that kind in this benighted country are encouraging evidences of progress in a direction where progress is much to be desired. It is saying but little to say that this exhibit, made under the auspices of the League for Social Service, has served a useful and commendable purpose.

LETTERS UPON PRACTICAL SUBJECTS.

A METHOD OF CUTTING LARGE CAST IRON GEARS.

The cut herewith shows the manner in which two cast iron gears were cut which were too large for any milling machine in the shop. The gears were three pitch gears having 72 teeth, the width of the gears being 3 inches. It was intended to send these gears to another shop to be cut when it was noted that the table of the Dill slotter in our shop was graduated into 360 degrees, and as 72 teeth were to be cut, the indexing for each tooth would equal 5 degrees. The two gear blanks were then mounted together upon a central pivot which projected slightly into the center of the slotter table. A high-



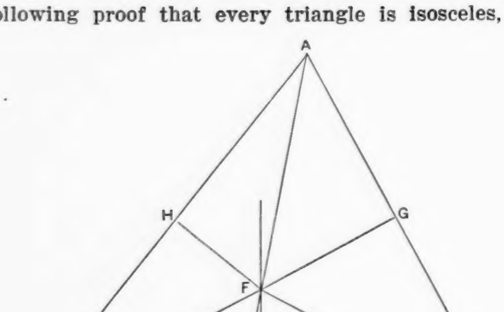
Method of Cutting Large Cast Iron Gears.

speed steel tool was filed to a shape slightly smaller than the width of the space between the teeth, and as nearly to the correct shape of the space as could be done without going to too much expense. This tool was used for roughing out the space between the teeth, using it in any regular slotter bar tool-holder. Then having a regular 3-pitch milling cutter on hand, this was bolted to a steel bar as shown in the cut. A keyway was cut in the hole and a small key inserted to keep the cutter from turning around upon its arbor. A finishing cut was then taken all around the gears, using the cutter as a finishing tool, the indexing being done carefully by moving the slotter table 5 degrees for every tooth. The two gears were cut in this manner in 10½ hours from the time they left the floor until they reached it again. I consider this very good time under the circumstances, only slightly more than four minutes per tooth. The gears came out practically perfect.

M. H. W.

EVERY TRIANGLE IS ISOSCELES.

It may interest some of the readers of MACHINERY to know that the proof given by R. S. in the December issue, as well as the following proof that every triangle is isosceles, may be



Every Triangle is Isosceles.

found in a book named "Lewis Carroll Picture Book," published a good many years ago. The proposition that every triangle is isosceles is proven in the following manner: Let ABC be any triangle. Bisect the line BC at D and from D draw a line at right angles to BC. Bisect the angle BAC. Let the bisector of angle BAC intersect the line drawn at right angles to BC at F. Draw FB and FC, and from F draw FG and FH at right angles to AC and AB. Now, the triangles AFG and AFH are equal because they have line AF in common and the angle FGA equal to the angle FHA, and the angle HAF equal to the angle GAF. Thus AH equals AG and FH equals FG. The triangles BDF and CDF are also equal because the line BF is common to both, BD equals DC and the angle FDB equals the angle FDC. Consequently the line FB equals the line FC. The triangle BFH is further equal to the triangle CFG because the line BF has been proven to be equal to FC and FH to be equal to FG, and the angle BHF is, according to the construction, equal to CGF. Thus, the line BH equals CG. We have previously proven that AH equals AG, consequently $AH + HB = AG + GC$ and $AB = AC$. This and every triangle is consequently isosceles. A great many mathematical "proofs" can be made in a similar manner, but the cause for the fallacy is apparent to the thoughtful observer.

T. S. BAILEY.

Quincy, Mass.

HUMAN NATURE IN TIME CARDS.

Most of us are interested, more or less, in the machine shop and the men we find there. Most of us, also, have at some time been in the larger shops, and are familiar with the usual factory systems, no part of which is more in evidence than the time card method of recording the employe's work; to those who have never particularly noticed, it is surprising to observe the amount of a man's character and general make-up which he unconsciously records on his own

Human Nature in Time Cards.

time cards. This fact is very apparent to the clerks and timekeepers, but nowhere is it shown to the average person as clearly as in those shops having a rack, with individual places for the men's cards, where the day's record for each man is placed, shoulder to shoulder as it were, with his shopmates'. In such places the time-card rack is in reality a bulletin of the character, habits and disposition of every man in that shop.

Stand up near the time-card rack about fifteen minutes before closing time some night and notice a few of the men, their time cards and the way they put them up. The first ones up are usually those of the old standbys, who have worked in the shop for years and whose habits are as regular as clockwork, always there when the whistle blows, and ready for work, though they never hurry, and they put up their time cards in a matter-of-fact way at the same time every night. With them life is merely a repetition, day after day, and their time cards show it plainly—always there, full time every day, never an order number missing, and, incidentally, no trouble to the timekeeper.

Notice this fellow coming up the line, stopping to watch what someone is doing now and then. Now he is putting up his time card and looking at the ones all around his at the same time, in an inquisitive sort of way. He is just the same at his work—always more interested in what the others are doing than in what he is doing himself—and that is the reason for most of his many mistakes.

There is an odd-looking card over there—the one on which the wording is all printed out. That man has a fad for lettering and if you happen around some noon you will see him putting in a few minutes practising. The clerk says he likes his time cards because they are so easy to copy off.

The one just under it looks as though a writing teacher or penmanship expert had executed it, so artistic is the writing. You won't find anything awkward looking or acting about the man behind that signature, and he takes real pride in the way he does his work, and especially in the way he finishes it.

Look up here in this corner at this man's time card—neat and clean—clearly written and nothing omitted; it doesn't look as though it had been lying around among his files for a week either. Yes, that is he over there cleaning up his bench and getting ready to go home—he matches his time cards in looks; he has good tools and plenty of them, and knows how to use them; his work is first-class and his name is well up on the rating list; he takes pride in his work and he would be a credit to any shop.

Here is his direct opposite coming up the aisle; look at him slouching along, overalls in rags, shoes falling off, hair uncombed! This is his time card—you can't mistake it—the oil-spotted one with the thumb marks that would put to shame the Chinese method of recording criminals. You can't make anything out of his hieroglyphics but the time clerk has had so many of them that he will translate them, though he may have to go down to see him in the morning; he usually does, and at the same time he will see that absent-minded fellow who forgot to put any order number on his time card. This is the same fellow who forgets to line up his centers after turning tapers, not to mention the borrowed tools he forgets to return.

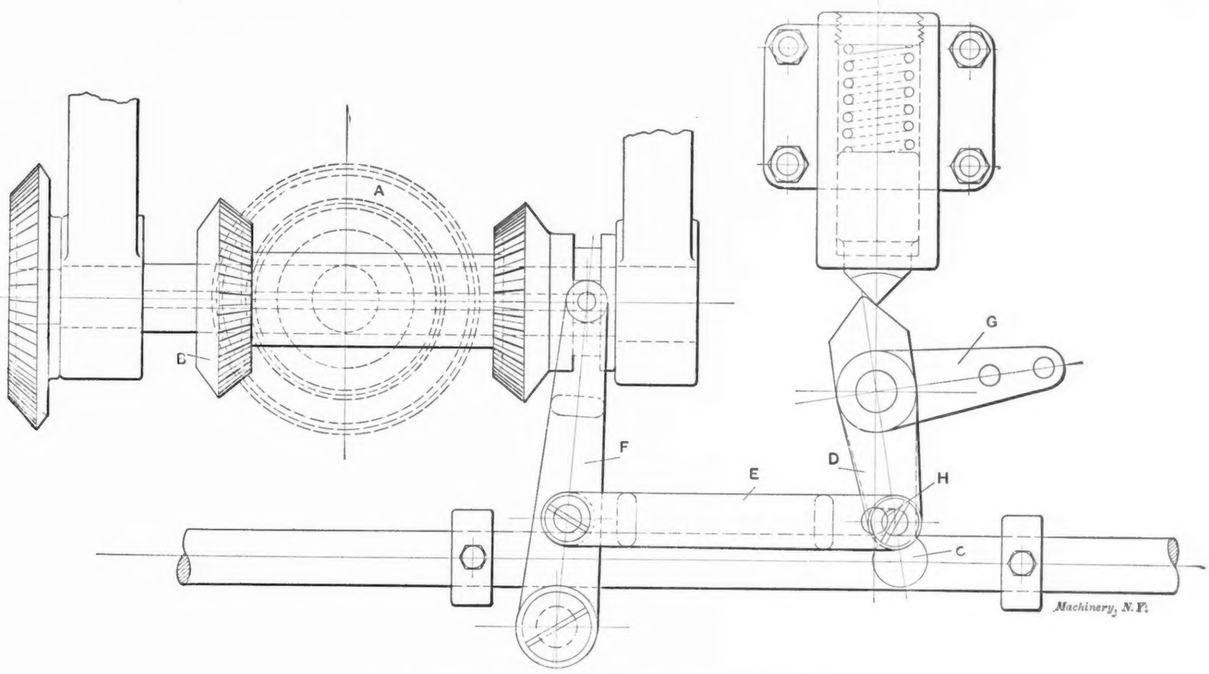
The cards are most all up now but by the blank places you can see there are one or two more to come unless they are absent. This apprentice racing down the line is last nearly every night; he was so busy cutting those threads that he forgot all about his time until the last minute. See him hustle his tools into his drawer so as to be ready to run when the whistle blows. He is the same youngster who helps the sweeper on his Saturday clean-ups and always inscribes his time card "Chasing the broom." There goes the whistle now and there goes the boy followed by the rest of the men with the old standbys bringing up in the rear.

With these few examples we have observed only the most striking of the little earmarks which show up the man whose labor the time card represents, but were we able and willing to go deeper into the subject or even beyond to the study of the handwriting itself the deductions we might make would lay bare human nature far clearer than words could depict. Although no amount of argument would convince the man behind of the truth of our observations, we cannot help seeing it and yet, after all, it is better thus, for what a bitter world it would be if "we saw ourselves as others see us!"

Lynn, Mass. CHESTER L. LUCAS.

AUTOMATIC REVERSING MECHANISM FOR GRINDING MACHINE.

The problem which led to the design of the reversing mechanism shown in the accompanying cut was to get a grinding machine for grinding the bores of cast steel car wheels, the bore being about 1½ inch diameter and larger. Owing to the hardness of the steel used in the wheels, no roughing cut could be taken before the grinding operation. This necessitated that sometimes up to ⅜ inch on the diameter had to be ground out, and in order to make the operating cost of the machine as low as possible it was equipped with automatic reverse for the back and forth motion of the emery wheel, and with automatic feed of the cut.



Automatic Reversing Mechanism for Grinding Machine.

One new feature of the machine in question is that the emery wheel is driven by an independent motor which is mounted on the emery wheel rest so that it travels with the emery wheel. The reversing of the traveling motion is obtained by a driving bevel gear, *A*, and an engaging double pinion, *B*, which can slide back and forth on the shaft, but is keyed to it in order to drive. When one end of the pinion engages the driving gear the carriage moves forward, and when the other end of the pinion engages the driving gear the carriage moves backward. This back and forth sliding motion of the pinion is caused by a system of levers, a plunger acted upon by a spring, and a shaft which is fastened to the bed of the machine and is equipped with two collars. By changing the distance between these two collars the length of the traveling motion is changed.

The illustration shows the pinion engaged so that the carriage will move backward. As the carriage moves, the lever *C* comes in contact with the rear collar. The lever moves and pushes the plunger upward, compressing the spring. During the first half of the period the link *E* does not move, owing to the oblong slot *H*, and gear *B* remains

fully engaged to the driving gear. When the levers *C* and *D* have passed the central position, the pressure of the spring comes into action and pushes the plunger downward. This moves the lever *D*, and by link *E* the motion is transferred to the lever *F* which causes the pinion to slide, disengaging one end and engaging the other. The carriage reverses and starts to move forward. In order to obtain the feed of the emery wheel the lever *G* is connected to the reversing mechanism. At the end of the lever two strings are fastened which are led up to the ceiling, and over sheaves lead down one to each of two ratchets at the end of the feed screw. These ratchets are arranged so that when the carriage reverses at the rear end one of the ratchets feeds, and when the carriage reverses at the front end the other ratchet feeds the cut. O. K.

FLAT FILING.

Too many beginners use a file as though it were a rubbing instead of a cutting tool. Others, again, lift the file clear from the work at each stroke end, to bring it back for the next cut. Either of these ways is apt to result in a "book-back" appearance of the work-piece. Lifting the file on the back stroke has a tendency to throw it out of level; if it be dragged over the work ever so lightly on the back stroke without removing any metal, it is more apt to keep in the same plane as on the cutting stroke.

As regards the pressure, at first the tip should get more, by means of the outstretched fore-finger, than the handle; in the middle of the stroke the pressures on the two ends should balance, and at the end of the stroke the handle should get it.

To practice flat filing, one may take a wood rasp and a piece of hard wood about as large as a thin brick, and file down the long narrow side avoiding "book-backing." After this is done, the best thing is to file a round brass rod to an even square cross section.

But after one has got a piece to what he thinks is the flat condition, he will be apt to find that the straightedge differs from him. Then if he will either clamp the work-piece in a freely swinging holder, or lay it on a piece of cork, he will find that he can file it still flatter. If the piece is very small, it may be filed on the forefinger. Either the swing, the cork or the forefinger follows the tendency of the file to rock, and enables the production of a flatter surface than would be otherwise attainable. ROBERT GRIMSHAW.

Hanover, Germany.

[To get the action of a swinging holder the work may, in some cases, be placed between the centers of a lathe.—EDITOR.]

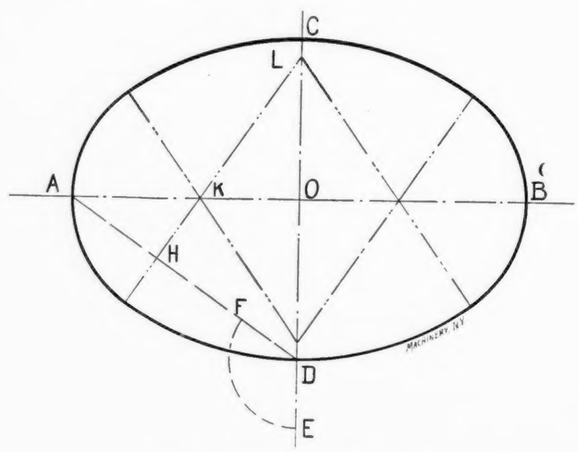
TO DRILL CHILLED CAST IRON.

The hardest chilled cast iron may be drilled by using a common flat drill made of good high carbon steel, as for example, "Crescent double special A-1." This steel can be hardened at a very low red heat which is an imperative requirement for a tool to drill hard material. It should be hardened in a solution of salt water. I have been able with a drill hardened in this manner to drill the hardest chilled iron that can be cast. It might be worth while to remark here that chilled iron can be still further hardened by bluing it on an emery wheel; it will then be so hard that no steel tool can touch it. It should be mentioned that a very powerful and rigid drill press must be used for drilling chilled iron as it takes a tremendous pressure to force the drill into the hardened surface. The attempt to drill chilled iron in a weak drilling machine will be futile as the drill will simply ride up over the surface, not cutting at all and quickly dulling the point. As to speed, I would say use a speed at which the drill will do a reasonable amount of work before dulling. Lubricants are of no advantage whatever. As a measure of speed I would say that it is impracticable to use a peripheral speed of the drill exceeding from 24 to 30 inches per minute. In planing chilled iron a speed of from 18 to 24 inches per minute should be employed and the same applies to turning. Do not attempt to drill chilled iron with an extra or specially machined twist drill; a twist drill has too much top rake to the cutting edges, hence is too weak to stand the pressure. Of course some so-called chilled iron can be drilled with a twist drill, but iron as hard as chilled rolls cannot.

Cincinnati, Ohio. M. B. STANFFERT.

DRAWING AN APPROXIMATE ELLIPSE.

Many of the methods of drawing an approximate ellipse are complicated and difficult to remember and some of them do not give good results unless the ratio of the larger and smaller axes is within certain limits. The cut herewith, which is a direct reproduction of a drawing made according to the method outlined below, shows a simple way of obtaining a very accurate elliptical form. The method is of German origin and is easy to keep in mind. The procedure is as follows: Let *A B* be the larger axis and *C D* the smaller. Draw the line *A D*. From the intersection of the axes, *O*, set off *O E* on the minor axis equal one-half of the larger axis. With *D* as a center and with *D E* as radius, strike the arc *F E*. Bisect *A F* at *H*, and from *H* erect a perpendicular intersecting the axes at *K* and *L*. These two latter points will then



Drawing an Approximate Ellipse.

be the centers for the radii *K A* and *L D* by means of which the approximate ellipse is formed. Of course, the centers for forming the other half of the ellipse are found in a similar manner. S. W. LINN.

Milwaukee, Wis.

[While the methods for drawing an approximate ellipse are many and commonly known, we give publicity to this one, as we consider it exceedingly simple, and think that it will be appreciated by those of our readers who are often called upon to make drawings where ellipses occur.—EDITOR.

GETTING A RAISE.

The best method of getting an increase in salary or wages, better known as a "raise," has been told us over and over again in the Sunday supplements and elsewhere; but there seems to me to be no safer way than that of asking for it and to repeat the request until the desired effect is produced, or the boss gets sore and assures you in plain language that you can't have it and that's all there is to it. A conscientious man will seldom get such a reply, although he may be put off with this or that excuse.

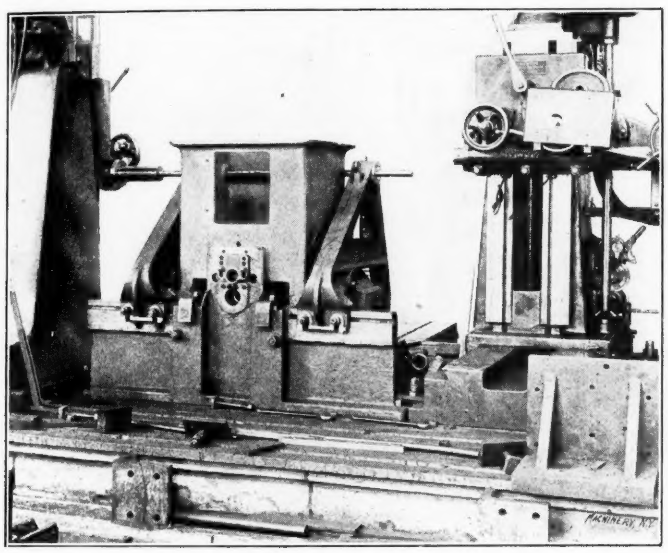
However, the fact that your immediate superior is not always to blame for these delays is illustrated by an experience which I had some two years ago, while working for one of the subsidiary companies of a very large corporation. The head of the department in which I worked was the mechanical engineer of the smaller concern, itself no "one-horse" affair; and I thought all that was necessary was for him to say the word, and my hoped-for bigger check would be a reality. After much maneuvering I got him alone one day and asked him about it; he replied that he thought I had been with the firm long enough to merit an increase, and so far as he was concerned he was perfectly willing to give it to me; but the policy of the company absolutely forbade raising the wages of any employe, though heads of departments could use their own discretion as to the amount to be paid a new man;

and he suggested that if I could get another place for a few weeks or months he could then hire me over at what he thought I was worth. At any rate, I had better get an offer from some other firm, and perhaps then he could fix me up with what might be called a "theoretical" discharge; for a while I was inclined to think he was simply letting me down easy, but I finally secured an offer from another firm in the same corporation, in the shape of a telegram, to come on at once at the figure named; told the boss about it that evening, and the next morning he telephoned to the head office in a distant city to see what could be done. The reply was that in no case could he give me a straight-out increase, but that he might have me taken off the payroll for one day, and start me in at the new rate the next, which he did; and I telegraphed the other people that I had already accepted a position. It was not a very square way to deal with them, but as they were part of the big organization whose red tape had put me to all the trouble, my compunction wasn't very great—not so as to be unendurable in the light of the following paydays. The next time I wanted more money I went elsewhere in earnest. BESSEMER.

Chicago.

A LARGE DRILLING AND BORING JIG.

The jig shown in the accompanying cut is used at the works of the Landis Tool Co., Waynesboro, Pa., for drilling and boring the beds of their smallest size grinding machines. The



Large Drilling and Boring Jig.

cut shows the work in progress on a large horizontal boring mill. The jig consists of a base provided with an adjustable plate for drilling the holes in the front, and adjustable brackets for guiding the bars for boring the ends of the bed. The base consists of a heavy casting, planed at the top, so as to correspond with the planed portion of the top of the bed, so that the latter may be laid bottom up on this base and located transversely by the planed lip on the front of the bed, suitable clamps being provided to hold it firmly in position. At the front of the base of the jig is a vertically projecting flange or apron of sufficient size, and so shaped as to conform to the shape required for locating most of the holes in the front of the bed; at the back part of the base is a smaller flange adapted for carrying a bushing for guiding the bar for one of the larger of these holes. Suitable T-slots are provided in the base for bolting on the various parts, and at the bottom two right-angle grooves are planed to provide for a tongue for locating on the floorplate of the boring mill. The jig is designed to accommodate two sizes of beds or similar cross sections but of different lengths, the difference being such as to only affect the location of the end brackets and some of the holes in the front of the bed. To provide for the difference of these latter holes, the adjustable plate in the front is so designed that it can be located by dowel pins in either of two positions required and is provided with slots for clamping bolts. When boring the holes in the ends of the bed the base of the jig is, of course, turned from the position that it has when the front holes are bored to the position shown in the cut. The end brackets are clamped in place, being located upon the finished surface of the base. T-slots are provided so that these brackets may be shifted in or out to accommodate the different lengths of beds. H. F. NOYES.

Waynesboro, Pa.

THE APPARENT FALLACY OF ALGEBRAIC PRINCIPLES.

In the January number of MACHINERY, R. S. has endeavored to overthrow our fundamental ideas of arithmetic and algebra. Such proceedings are dangerous and I hasten to raise an objection to his methods and results. It would be a dangerous thing if two became equal to one in the matters of every day life. His algebraic processes are perfectly legitimate up to the point where he says, "divide both members by $a - b$. The quotients are then equal." According to his first assumption $a = b$. Therefore $a - b = 0$. It is ordinarily assumed that it is perfectly correct to divide both sides of an equation by the same quantity. This is true unless that quantity is either infinity or zero. If both sides of an equation are divided by infinity or zero, the result is not necessarily correct as it becomes an indeterminate. This may be easily seen by taking a numerical example. For instance, 0 times $7 = 0$ times 9. If we should divide both sides of this equation by zero we would have as a result $7 = 9$, exactly as R. S. has proven that $2 = 1$. I hope that this explanation will convince R. S. that our fundamental laws of arithmetic and algebra still hold good in spite of apparent discrepancies here and there. I might say in conclusion that the two quantities, zero and infinity, must be handled very carefully in algebraic operations. K. G. SMITH.

Wellsville, N. Y.

PORTABLE MACHINES FOR TURNING CRANK-PINS AND CROSSHEAD PINS.

In the accompanying cut, Fig. 1, is shown on a small scale a crankshaft for a 50 x 72-inch reversing blooming mill engine. This shaft was made by the Bethlehem Steel Co. and weighs

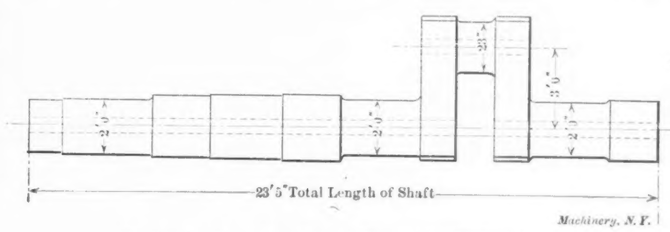


Fig. 1. Crankshaft of Large Blooming Mill Engine.

49,000 pounds. As there is no lathe in the Pittsburg district powerful enough to swing this crankshaft, the crankpins, when worn, had to be filed true by hand, a very unsatisfactory and expensive operation. For this reason the writer designed the

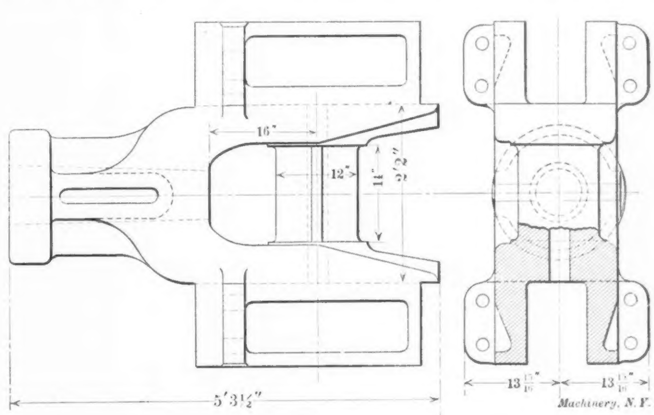


Fig. 2. Crosshead of Large Blooming Mill Engine.

portable crankpin turning machine shown in Fig. 3. This machine consists of frame A made in two parts and clamped to the crankshaft by the brackets B, rods C and pivot D. The frame carries a ring E, also made in two parts, to which the

tool rest *F* is bolted. The lead screw *G* is operated by a star feed. The outer surface of the ring *E* is a wormwheel driven by a worm carried in the frame *A*, all of which is plainly shown in the cut. A sheave pulley is keyed to the wormwheel shaft and is driven by means of any convenient transmission of power. This apparatus has given entire satisfaction, and it may be changed so as to meet almost any case liable to arise.

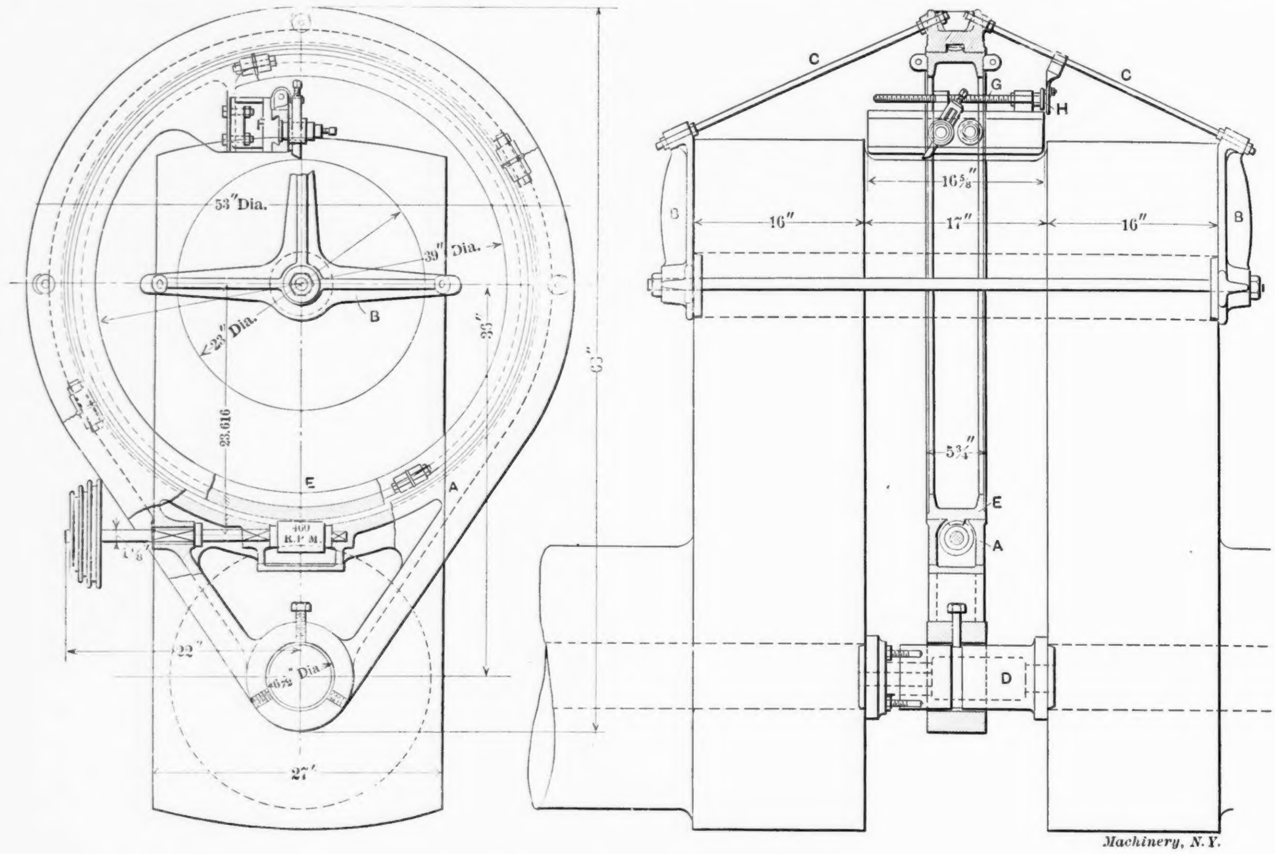


Fig. 3. Portable Crankpin Turning Machine.

The writer has also designed a similar tool to turn the crankhead pins for a 50 x 72-inch blooming mill engine. This tool is shown in Fig. 4 and the crosshead with its pin is shown in Fig. 2. There is no other mechanical way, excepting the one shown, known to the writer by which this operation can be carried out. This tool is to a certain extent very much similar to the one first described. It consists of a frame made in two pieces. Inside of this frame is a wormwheel, carrying the tool, driven by a worm and a sheave pulley, the same as in the tool first described. The dimensions of the outer frame are such as to permit it to be placed between the crosshead pin and the crosshead itself. As will be seen from the cuts, the radius of the frame is 15½ inches, while the distance from the center of the crosshead pin to the solid back part of the crosshead is 16 inches. It is obvious that the frame as well as the wormwheel has to be made in two parts, as otherwise there would be no way of placing the piece to be turned in position inside of the arrangement. F. WACKERMANN.

Pittsburg, Pa.

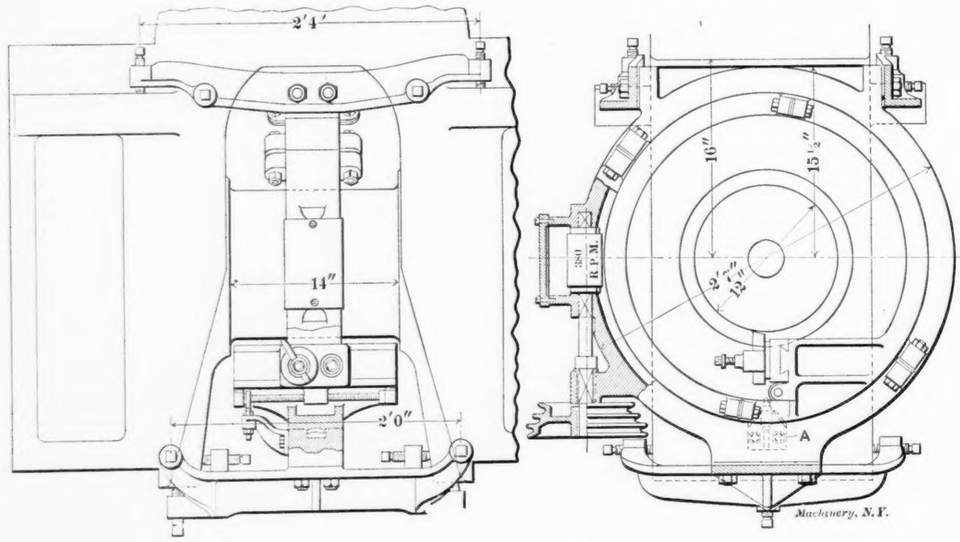


Fig. 4. Portable Crosshead Pin Turning Machine.

THAT ALGEBRAIC PARADOX.

Referring to the algebraic paradox in the January issue, would say that it is not necessary to use algebraic symbols at all; use only the figure 1; thus:

$$1 = 1$$
$$1^2 = 1 \times 1$$
$$1^2 - 1^2 = 1 \times 1 - 1^2$$
$$(1 + 1)\ (1 - 1) = 1(1 - 1)$$
$$(1 + 1) = 1$$
$$2 = 1.$$

Or use any old figure,

$$7 = 7$$
$$7^2 = 7 \times 7$$
$$7^2 - 7^2 = 7 \times 7 - 7^2$$
$$(7 + 7)\ (7 - 7) = 7(7 - 7)$$
$$(7 + 7) = 7$$
$$14 = 7$$
$$2 = 1.$$

Which all reminds me of that no cat has two tails; any cat has more tails than no cat; therefore any cat has more than two tails.

GEO. B. GRANT.

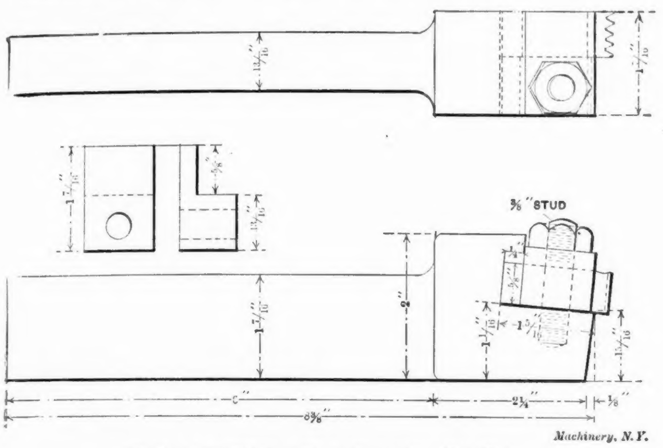
Boston, Mass.

[It is worth while noting, particularly by those who only occasionally make use of algebraic formulas, what fallacious conclusions may be drawn from apparently correct use of algebraic expressions. While the laws of mathematics are infallible they demand a constant alertness of the mind not to permit any operations to be performed, which, while apparently correct, are illogical.—EDITOR.]

UTILIZING WORN THREADING DIE CHASERS.

Having a number of Hartness threading die chasers of various pitches, which, after having earned their cost several times over in the Jones & Lamson turret lathes, had become worn on the first two or three threads so as to become useless for the die head, it struck me that these might be used for finishing threads in the lathe by planing them in a suitable holder.

I then made a holder like the cut, and instead of only finishing threads in the lathe it was found that in most cases a thread could be completed in three cuts. After a lathe hand became accustomed to their use there would be no necessity to remove the piece from the lathe to try to fit, but if care had been exercised in first turning the piece to the correct diameter, just as soon as the chaser became filled with the thread the fit was assured. Now, when one gets one of these chasers of any particular pitch, of course one gets four, there



Holder for Utilizing Worn Threading Die Chasers.

being four to a set. I then had the first threads, which were originally tapered or chamfered off, ground away on two chasers in the set to be used when threading up to a shoulder. I left the other two chamfered as they were originally. So successful has this method become that I have found several turners getting the holders made on the "sly," and if not able to secure worn out chasers, to even try to "pinch" good ones from the turret lathe men, which I think is sufficient recommendation to warrant all interested giving it a trial. I am satisfied that threads can be cut so much faster and more accurately by this method that it would even pay to use the new die chasers were no old ones procurable.

Referring to the cut, very little explanation is necessary. The reason for the part of the holder upon which the chaser rests being made angular is to allow sufficient clearance to form a good cutting rake. This was found to be absolutely necessary after actual trial. The top rake, shown ground in the chaser, was found to be better for steel work. I have also made a holder suitable for inside work which I do not think it will be necessary to describe, as any mechanic could devise one. I merely submit the idea to those who may have some of these old chasers lying around the shop, and who have not thought of putting them to use. M. H. W.

HIS NAME WAS DENIS.

It takes all kinds of men to fill up a shop, but it seems as though such a man as Denis might have been left out. Denis was a good fellow all right, but he had a faculty for getting into scrapes. His first job when he struck us, was turning press rolls; they are the distributing rolls used on large job printing presses. Any of you printer fellows will know just what I mean; there is a roughing and finishing chip run over the roll and then the journals are turned up. We were pressed for long lathes to get this work out fast enough, so Denis had to do a lot of overtime work. He ran two lathes, he would rough out on one and then finish on the other.

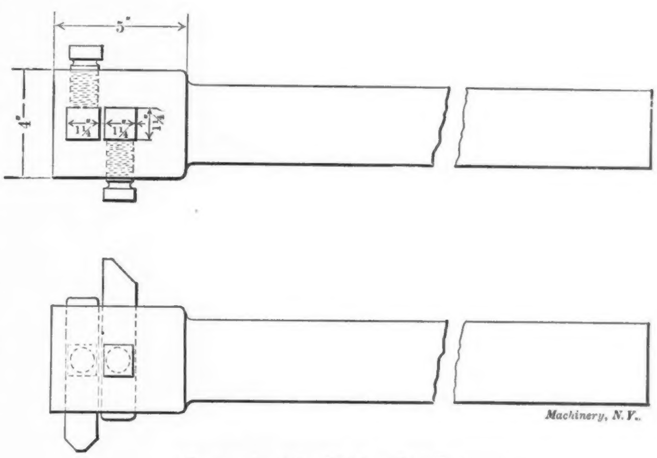
Well, it came to Thursday night and Denis had worked three nights that week, and then he wanted a night off; you boys that ain't married know just how he felt. He didn't dare ask the "Boss" to be off; he knew it was no use; but instead of that he had an inspiration. He started a cut on each lathe as soon as the power started up at 6:30. Then he tied a string on the end of the shipper and the other end of the carriage so that when he had got to the end of the cut, it would pull the clutch out and stop the lathe. The idea was great; but the thing miscarried, in the application. One of the cubs saw what was up, and he gave the cross-feed handle a turn and drew out the tool so that the lathe run on a "wind chip" all the evening. The next morning when the "Boss" came in, he wanted to know why the work wasn't done, and then the whole thing came out. Denis didn't get fired, but he got a "call-down" that will stay with him for a while.

A new man came in about this time and he told us about one of Denis' old feats. It seems he had been put on a big double-head planer; how it came about we couldn't say, and he couldn't tell us, but he got there somehow. The first job was a big locomotive cylinder. Now the planer was served by an overhead crane that dropped the work on the rear end of the table behind the cross-head. Denis set the job up without running it to the front end of the planer. So far, that was all right, but then he started up the planer without looking to see if the cross-head was up far enough to clear the work. Well, it wasn't! It only lacked an inch, but when that casting struck the back end of the heads, it naturally ripped the "stuffing" out of them, for they were not built to take the thrust from that side.

About the time Denis saw the heads going, he had his coat on and was out of the door, and, as the new man continued, "I hadn't seen him since, until I struck here. It cost about five hundred dollars to put the planer back in shape, but that didn't worry Denis any." A. P. PRESS.

BORING TOOL FOR LOCOMOTIVE DRIVING BOX BRASSES.

The accompanying cut shows a boring bar for boring the driving box brasses on locomotives. It may not be new, but having traveled a great deal this summer among railway repair shops I have not seen it in use in any of them. As the brasses are only half a circle, by using only one tool in the toolholder it is evident that work is performed only half of the time, and the machine is not working the other half. But by making the bar as shown and placing a second tool above the first a cut will be taken during the whole revolu-



Boring Tool for Driving Box Brasses.

tion, as one tool commences to cut just as the other leaves off. In many instances, if there is not too much to bore out in a box, it may be finished in one cut, for no matter how heavy a cut is taken by the first tool it leaves off cutting when the second tool commences to take the finishing cut and permits the latter tool to produce a smoothly finished surface. It may be objected that one tool will leave the bore slightly before the other at the end of the cut. To avoid this the second tool may be made with an offset sufficient to bring them both through at the same time. I have also adopted this method for work performed in a horizontal boring mill; by boring the holes which receive the cutters to within ⅜ inch of the opposite side and tapping out the remaining wall with a ½-inch tap and inserting a setscrew, I have secured a good adjustment, which saves setting the tool with hammer blows, which I have frequently seen done during my travels.

M. H. W.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

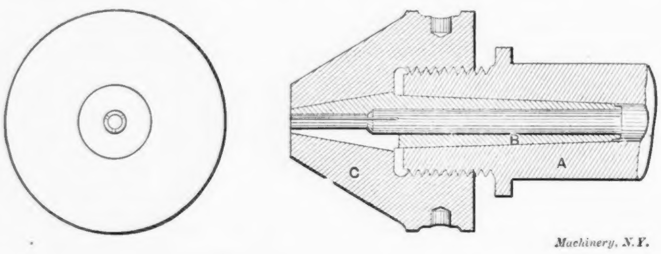
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

DRILLING PORCELAIN OR GLASS.

To drill porcelain, glass, etc., take a piece of iron wire 1/32 inch smaller than the hole desired and grind one end flat; place it in the drill chuck and speed the drill as high as possible. Feed slowly through the substance, using plenty of emery and oil. NERALCM.

A COLLET CHUCK.

About twenty-four years ago, when the writer was serving an apprenticeship in the toolroom, the "old man" designed a collet chuck of which the sketch herewith is drawn from memory. The principle is not new, but I can vouch for the utility of the tool. We had a good 14-inch lathe with hollow spindle but no collet chucks. Referring to the sketch it will

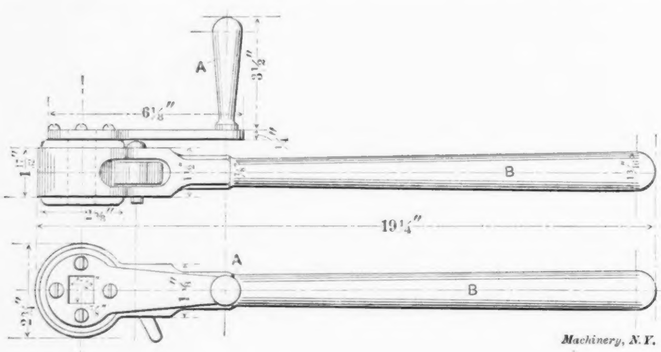


be seen that *A* represents the lathe spindle, *B* the tool steel collet and *C* the cast iron compression nut. Several collets were made with holes of various diameters, the largest size being limited by the capacity of the hollow spindle. The collets were split in three parts as shown. The edges of the compression nut were knurled for a hand grip which was sufficient for ordinary work, and spanner holes were also provided. H. D. POMEROY.

Rome, N. Y.

THE REVERSIBLE RATCHET WRENCH AND HANDLE.

The accompanying cut shows a very good improvement on the ratchet wrench used for heavy machinery such as slotters, planers, wheel lathes, and boring mills for operating feed mechanisms, traversing motions, etc. It is in use in the Clinton shops of the Chicago & Northwestern Ry. at Clinton, Iowa. With the small handle *A* attached, the wrench is a combination ratchet and ordinary wrench, and it can be used to good advantage as it is not necessary to remove the wrench from the screw if a quick traverse is desired. For heavy work the long handle *B* is used with the ratchet, and for lighter and

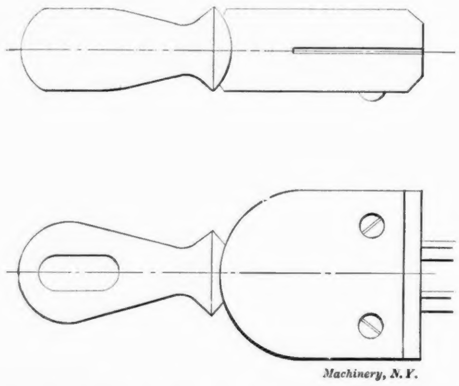


quicker work the short handle is operated. This is an important consideration on many machines for the number of changes that must be made in the use of wrenches on screws frequently amounts to a large percentage of a 10-hour day. The small handle can be applied to almost any reversible ratchet wrench used on machine tools, and the cost of application is very small indeed as compared with the increase of efficiency of the tool. It will readily repay the cost of the outlay in a very short time. HARRY F. KILLEAN.

Clinton, Iowa.

SPACING TITLES ON DETAIL WORK.

A drafting-room kink came to my notice some time ago which I have found very useful as a time saver in spacing titles on detail work. It consists of a few needles and a small piece of wood turned as is shown in the cut. Through one end a narrow saw cut is made about an inch deep. Into

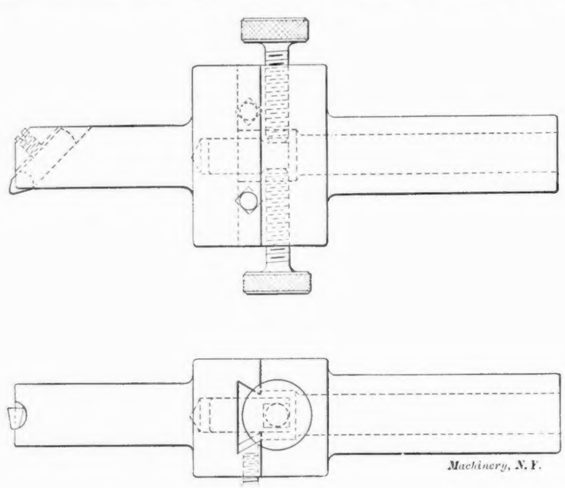


this cut are inserted and spaced as many needles as are desired. The needles are bound in place by two round-head wood screws. The cut shows such a spacer set to mark for two lines of letters. RAYMOND C. WILLIAMS.

Worcester, Mass.

BORING TOOL FOR USE IN SCREW MACHINE.

The cut herewith shows a boring tool made for use in the turret lathe, chiefly for operations upon castings. The main feature of the tool is the means provided for setting the tool, which can be quickly and accurately accomplished with the aid of the two knurled head screws, the ends of which impinge upon a stop driven into the cutter holder body. After setting, the knurled head screws are firmly locked up against



the stop. The tool steel cutter is held in position in the holder by means of a headless setscrew, which is sufficient to hold it firmly in position. The shank is turned to suit the hole in the turret, the wear in the slide is taken up by means of a gib and setscrews. The stop pin is driven firmly in position through the hole in the shank after the tool is assembled.

J. C. H.

* * *

In making repairs it usually is not a question whether a piece is worth patching up or not, but whether a manufacturing plant can afford to lie idle while new parts are made or requisitioned from the manufacturer. Constructive work and methods are then permissible which would be out of the question in manufacturing work; it would be the height of poor judgment for a repair man to say that it were better to throw away a broken part and make a new one if by any hook or crook he could get it into working shape, and so save the time of men waiting for the wheels to turn again.

* * *

Don't run a polishing wheel on brass work for any great length of time without having a dust trap over your mouth and nostrils; a wet sponge is very good.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

310. ACID PICKLING FOR FORGINGS.

To remove scale from drop-forgings which have to be machined, dip in a pickle composed of hot water 24 parts, sulphuric acid 1 pint. HARDENER.

311. GOOD CASEHARDENING MIXTURES.

One part sal-ammoniac and 3 parts prussiate of potash; or, 1 part prussiate of potash, 2 parts bone dust and 2 parts sal-ammoniac. E. H. McCLINTOCK.

West Somerville, Mass.

312. LUBRICATING OIL FOR HEAVY DUTY AND FAST RUNNING JOURNALS.

An excellent lubricating oil for heavy duty and fast running journals may be made by mixing equal parts of sperm oil, cylinder oil and "black strap" or common machine oil.

Moline, Ill. A. D. KNAUEL.

313. EMERGENCY REPAIRS OF BOILER FURNACE.

When it is necessary to repair the boiler furnace and fire brick cannot be obtained, take common earth, mix with water in which has been dissolved a small amount of common salt. Use this mixture the same as fire clay. It will be found to last almost as long. R. E. VERSE.

314. COMPOUND FOR POLISHING BRASS.

To 2 quarts of rainwater add 3 ounces of powdered rotten stone, 2 ounces of pumice stone and 4 ounces oxalic acid. Mix thoroughly together and let it stand a day or two before using. Shake it before using and after application polish the brass with a dry woolen cloth or chamois skin.

Middletown, N. Y. DONALD A. HAMPSON.

315. LUBRICANT FOR DRILLING COPPER.

The best thing in my opinion to use for drilling copper, especially with small drills, is a piece of tallow. I have noticed a great number of receipts given, but I find that this simple means answers the purpose equally well or better than anything else. GEO. W. SMITH.

Marquette, Mich.

316. MIXTURE FOR CLEARING BLUEPRINTS.

It very often occurs, when making blueprints, that a print becomes burned by over-exposure and the lines do not show up well. These may be brought out more clearly by pouring bi-chromate of potash, dissolved in water, over the print while it is in the sink. The print must be washed again with water before it is hung up to dry. HERBERT C. SNOW.

Cleveland, O.

317. TURNING COPPER.

Those who have had to turn copper in the lathe have generally wished that they had let someone else do the work and that they stood by and jeered when it was being performed, or else criticised it after it was done. Soap and water do not help; turpentine is a delusion and a snare; but milk does the trick "with neatness and dispatch." ROBERT GRIMSHAW.

Hanover, Germany.

318. TO REMOVE RUST FROM POLISHED STEEL.

It quite frequently happens that parts of machinery having polished surfaces become rusty. This rust is difficult to remove without scratching the highly polished surface. A very effective mixture for removing rust from such surfaces without injury may be made as follows: Ten parts of tin putty, 8 parts of prepared buckshorn, and 250 parts of spirits of wine. These ingredients are mixed to a soft paste, and rubbed in on the surface until the rust disappears. When no trace of rust seems to remain, the surface is polished with a dry, soft cloth. T. E. O'DONNELL.

Urbana, Ill.

319. CASEHARDENING PROCESS FOR COLD ROLLED STEEL.

To successfully caseharden common cold rolled steel so that it will answer for the cutters of inserted reamers, etc., pack the cutters in granulated raw bone in a cast iron box with at least one-half inch layer of bone between the cutters and the sides of the box. Put on an iron cover and lute with fire-clay; heat in a gas furnace to almost a white heat for from two to five hours according to the size of the box. Then draw the box, open and dump quickly into a bath composed of the following: 1 quart of vitriol (sulphuric acid), 4 pecks common salt, 2 pounds saltpeter, 8 pounds alum, 1 pound prussiate potash, 1 pound cyanide potash and 40 gallons soft water.

S. Pittsburg, Pa. F. WACKERMANN.

320. ETCHING ACID.

I have noticed in MACHINERY a number of times receipts for etching acid to be used on steel. These receipts mostly call for two-thirds muriatic acid. I find that the object of the muriatic acid is simply to remove the grease and foreign substance from the steel, and that if only enough muriatic acid is used to accomplish this purpose, the etching acid will work better and quicker. I have used etching acid with muriatic and nitric acids in almost all proportions and have found none so good as two-thirds nitric to one-third of muriatic acid. In some cases I have had good success even with a less proportion of the latter ingredient. GEO. W. SMITH.

Marquette, Mich.

321. TO PICKLE BRASS CASTINGS.

An excellent mixture to use for cleaning and brightening brass castings is as follows: Two parts, by measure, of nitric acid, and three parts of sulphuric acid. To each quart of the acid mixture made up, add one pint of common salt and stir until dissolved. The solution may be held in any suitable receptacle, say, of glazed earthenware. It is only necessary to provide a vessel large enough for the immersion of the largest piece to be dipped. The pieces are simply dipped and removed at once, and then rinsed in clear water. This solution is intended only for cleaning and brightening the castings, and not for imparting any color. T. E. O'DONNELL.

Urbana, Ill.

322. PLASTER OF PARIS FOR PATTERN MAKING.

For experimental purposes and where but a few castings of medium and light weight are required, plaster of paris has many good advantages as a material for pattern making. It is light, it can be given a smooth surface, it is easily given any required shape and it can be added to indefinitely. While it is brittle, this is more than offset by the saving in first cost and the quickness with which the pattern may be prepared. Plaster of paris sets in from three to six minutes, but if for any reason it is desired to keep the mass plastic for a longer period, one drop of glue to a five-gallon mixture will keep it soft for a couple of hours. Plaster of Paris mixed with cold water has an expansion of about 1-16 inch to the foot when hardening. Should this be undesirable, mix with warm water or lime water and there is no expansion.

Middletown, N. Y. DONALD A. HAMPSON.

323. GOLD SOLDERS.

Gold solder suitable for 18-karat work: Gold, fine, 1 ounce; silver, fine, 144 grains; copper wire, 96 grains. (Troy weight.)

Suitable for 16 karat work: Fine gold, 1 ounce; fine silver, 144 grains; copper wire, 168 grains.

Suitable for 15 karat work: Fine gold, 1 ounce; fine silver, 240 grains; copper wire, 240 grains.

Suitable for 14 karat work: Fine gold, 1 ounce; fine silver, 300 grains; copper wire, 300 grains.

Hardest silver solder: Fine silver, 1 ounce; shot copper, 120 grains.

Best hard silver solder: Fine silver, 1 ounce; shot copper, 105 grains; spelter, 15 grains.

Medium silver solder: Fine silver, 360 grains; shot copper, 96 grains; spelter, 24 grains.

Easy silver solder: Fine silver, 336 grains; shot copper, 108 grains; spelter, 36 grains. H. D. SCHATTLE.

Syracuse, N. Y.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

W. J. B.—The piston rod of a 22-inch cylinder Corliss engine, being broken, had to be replaced. The new rod was turned to a diameter of 2 29/32 inches, the hole in the piston being 2 57/64 inches, or 1/64 inch less than the diameter of the rod. In order to shrink the piston on the rod, the former was heated to a dull red, but the rod refused to enter the hole. It was then turned down about 0.008 inch more, or half of 1/64 inch. The piston was again heated, but the rod still refused to enter. Upon measuring the hole of the piston when heated it was found that the hole was smaller when the piston was heated than when it was cold. Now, the question is what is likely to have been the cause of the hole in the piston being smaller when heated? Could the piston being hollow have anything to do with the matter?

A.—If any of the readers of MACHINERY have had any similar experience or think that they can satisfactorily explain this occurrence we should be glad to hear their opinion.

R. A. W.—A rod of ¼-inch Stubbs steel 24 inches long, annealed and coiled into an open helical spring 1½ inch inside diameter, 2 inches long, was given a spring temper and placed on a 1½-inch diameter round punch to act as a stripper; when compressed to about 1½ inch it was only strong enough to strip 1/16-inch aluminum when the punch was ground sharp and slightly concaved on the end. Another spring, open helical as above, made from No. 6 Brown & Sharpe round rolled spring steel wire ⅝ inch inside diameter, 1 inch long, mounted on a 17/32-inch diameter round punch and compressed solid, was only strong enough to strip 1/16-inch aluminum, the punch being ground sharp and slightly concave, as before. I would like some data from the experience of others which would enable us to figure accurately the spring pressure required to strip stock of different metals and thicknesses from punches of various diameters. We would use positive strippers, but could not do so in the case cited.

A.—The above question is submitted to our readers for answer. Anyone having data on this subject is invited to submit it for publication.

C. K.—Is it necessary to mix anything with cyanide of potassium when it is melted in an iron pot for use in casehardening? I have tried to melt some and instead of melting, it all dried up like flour and would not melt at all. What was the cause of the trouble?

Answered by E R Markham.

A.—The trouble referred to is probably due to the cyanide having been for some time exposed to the air and thus becoming "air slaked." I have used many tons of cyanide in various forms, but have always been very particular to keep it tightly sealed in cans, or some other receptacle excluding the air. When kept in this manner I have never had any trouble in melting it.

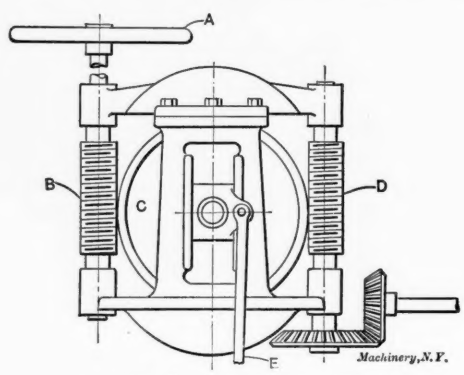
G. C. M.—Will the lead be the same in two pipe taps of the same size if one is chased with the taper attachment, and the other with the tailstock set over? The tool in both examples is to be set level with the axis of the work.

A.—No, but the difference is slight with the standard pipe tap, i. e., that having a taper of ¾ inch per foot. In the case of two pipe taps, one threaded with the taper attachment (good practice) and the other with the tailstock set over (bad practice), the number of threads in a length of 12 inches will be in the ratio of 12 to 12.006; assuming a lead of 14 threads per inch, there would be 168 threads on 12 inches axial length of the first tap and 168.084 threads on the second. Setting the tailstock over decreases the pitch, as measured on the axis of the tap. The pitch decreases with an increase of taper of the tap, and is inversely as the secant of half the included angle. For example, in the case of a standard pipe thread, half the included angle is 1° 47′ 23″ and the secant is 1.0005. Therefore, the ratio of the side of the tap to its axis is in the proportion of 1.0005 to 1, and the actual pitch to the apparent pitch is as 1 to 1.0005. If half the included angle were 31 degrees the secant would be 1.1666, showing that the taper side is one-sixth longer than the axis. Consequently, if a tap of this extreme taper were threaded with the tailstock set over, the axial pitch would be only six-sevenths of the pitch measured on the taper.

AN INGENIOUS SUBSTITUTE FOR THE FLOATING LEVER.

In the catalogue of an English firm building heavy metal-working machinery is shown, incidentally, a neat arrangement for performing the functions of the floating lever—a device generally used in waterwheel governors, steam steering apparatuses and other mechanisms in which it is desired to determine by sensitively moved levers, etc., the position of heavy parts requiring great power to shift their position. The advantage which the device shown in the cut would appear to possess over the floating lever is that its range is practically unlimited, so it may be arranged to control movements of great extent without sacrificing the compactness of the arrangement.

The handwheel *A* is the controlling element. It is connected with a worm *B* meshing with a wormwheel *C*. The shaft of this wormwheel is journaled in boxes which are free to slide up and down in vertical slides in the frame work which supports it. On the opposite side of the wheel is worm *D*, which is rotated by the heavy parts whose motion is to be controlled. Any vertical displacement of the wormwheel is transmitted to the rod *E* which operates the valve, belt shifter, clutch lever, or other device used for starting, stopping and reversing the driving machinery. Let it be supposed that the mechanism is



Substitute for the Floating Lever.

at rest with the wormwheel midway between its upper and lower position in the vertical slides of the housing, and the operator desires to locate the position of the heavy part whose movement is controlled by the arrangement; it may be a rudder, a waterwheel gate, or what not. He revolves the handwheel in a direction corresponding to the motion he desires. This rotates worm *B*, but as worm *D* is stationary since the mechanism is not yet in motion, the rotation of the handwheel has the effect of rolling the wheel *C* between the two worms, either up or down, depending on the operator's movements. The operator may rotate the handwheel to a position corresponding to the new adjustment he desires. The vertical displacement of the wheel just described will work the valve or clutch levers, and start the machinery in motion to bring to pass that new adjustment. As soon as a proper rearrangement thus started has been effected, the rotating of worm *D*, connected with the moving parts, will return the wormwheel to its vertical position and thus close the valve or release the clutch which made the movement possible.

* * *

Consul R. S. S. Bergh, of Gottenburg, in reporting on the Swedish experiments in making alcohol from peat, states that these experiments were started in 1903, the government and private persons jointly advancing the money necessary. It is claimed that satisfactory results have been obtained, especially as it has been found that the by-products of the process can also be sold. A company, Aktiebolaget Tourbière, has now been organized in Stockholm for the purpose of exploiting the invention. It is stated that the inventor thinks that the price of alcohol made from peat will be less than one-half of the present price of alcohol and lower than the lowest price of refined petroleum. This latter statement we must, of course, accept of with a certain amount of reservation, because experience teaches that what the inventor *thinks* is not always to be taken for granted.

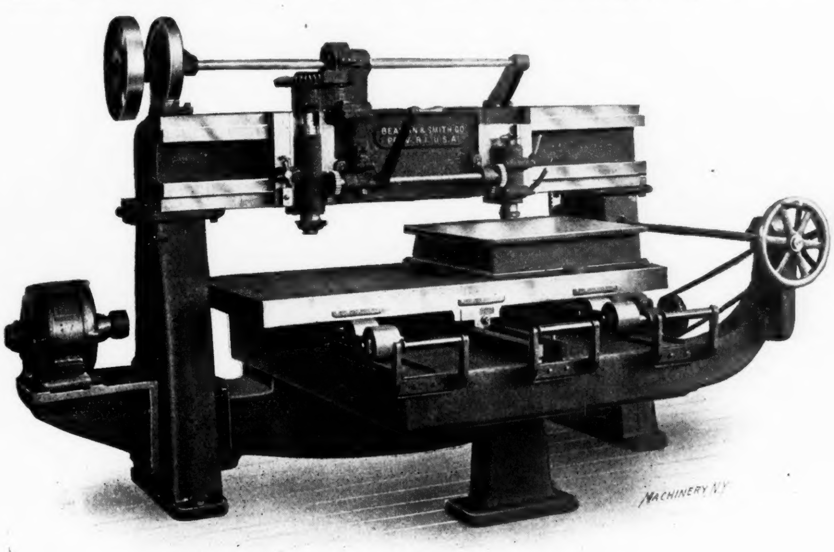
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

AN UNUSUAL PROFILING MACHINE.

The machine shown below is designed for profiling the beveled edges of irregular shaped retort covers. While this is an operation somewhat outside of the regular run of work found in machine shops, the principle of the machine is exactly similar to that of the ordinary profiler; and it is so much heavier and of so much greater capacity than anything of the kind of which we have any knowledge, that it is a decidedly interesting machine. It has proved to be an eminently successful one as well.

To the cross rail, supported by the two heavy uprights shown, is mounted a carriage carrying at the right the former roll and at the left the cutter spindle. These two parts move longitudinally with each other owing to the fact that they are supported by the same carriage. Their vertical movement is also simultaneous; the bearings which support them are gibbed in vertical ways and may be raised or lowered together by the operation of the lever shown, which is connected to a rock shaft carrying gears at either end, meshing with racks attached to the two slides. The spindle is driven through bevel and spur gearing from a motor attached to a vertically adjustable bracket on the left-hand column; the vertical adjustment provides a means for maintaining the proper tension on the belt. For traversing the carriage on the cross rail, the handwheel at the right is provided, which, through the shaft extending to the rear of the machine, operates a sprocket driving a Renold silent chain, which in turn operates a pinion meshing with a rack attached to the carriage. This rack is double so that it may be adjusted to take up back lash due to wear. The chain has also a fine adjustment to insure constant and uniform motion between the hand-wheel and the carriage movement.



Profiling Machine for Large Work.

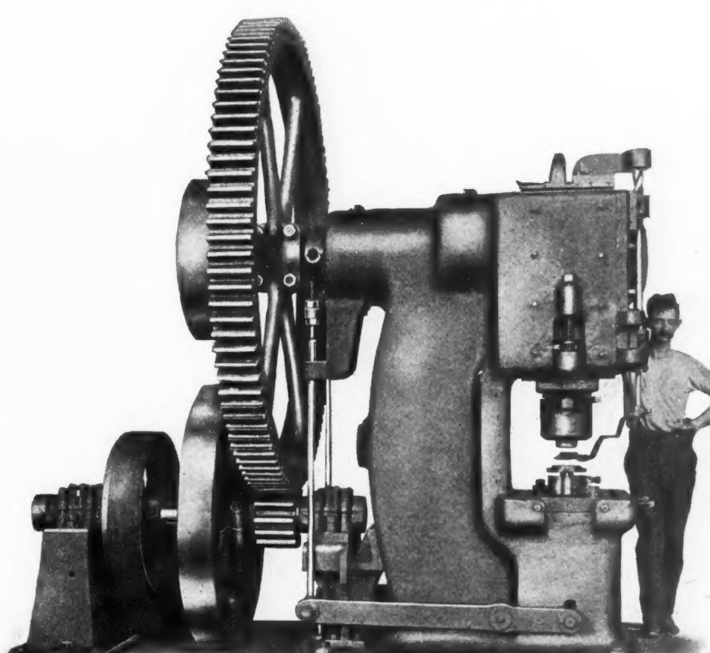
The work is supported on a broad table resting on a train of rolls on either side, which run in tracks provided for them in upper surface of the bed. This bed is supported at the rear by a cross rail between the two uprights, and at the front by a pedestal—thus giving a three-point bearing to the whole apparatus. For moving the table in and out a rack is attached to it, meshing with a pinion operated by a hand-wheel in a way similar to that just described for the carriage mechanism. This rack is also double and, as a means of alignment for the table and work, is confined in a planed groove or slide in the top of the bed. This rack slide and the two trains of rollers are protected from chips by canvas covers, not shown in the photograph. The table carries an auxiliary platen for the formers.

The distance between the centers of the spindles is 36 inches. The saddle has 36 inches of movement on the cross rails and the table has 40 inches of movement front and back. The table is 72 inches long by 36 inches wide, the distance between the uprights being 74 inches. The machine weighs about 11,000 pounds and was built by the Beaman & Smith Co., Providence, R. I.

A HEAVY WASHER PUNCHING MACHINE.

Some time ago (May, 1905, to be exact) we illustrated a press built by the Krips-Mason Machine Co., 1636 N. Hutchinson St., Philadelphia, Pa. This press was specially designed for the manufacture of washers with either single or multiple dies, and involves in its construction provision for stripping the work and the waste from both punch and die, and for presenting the stock to the cutting parts without injuring the operator. In the cut below we show a machine of the same type by the same makers, but of much greater capacity, it being possible with this tool to work ⅜-inch stock, and to blank out washers having a maximum outside diameter of 21 inches and a maximum inside diameter of 6 inches.

The punch is provided with a shedder and the die with a stripper, both positively actuated, the one by a cam on the rear end of the main driving shaft next to the gear, and operating through the system of levers shown, the other worked by a stationary adjustable bar passing through a slot in the ram. This system gives results similar to those obtained by the sub-press in small work so far as concerns the ability of the machine to use thin and delicate materials like paper, fiber, etc., and its ability to produce blanks from heavy stock perfectly flat and free from burrs or turned up edges. A carrier is provided for inserting work which has to be done piece by piece. This is in the form of an arm pivoted to a vertical shaft, rotated to right and left by the movement of the ram through the medium of helical grooves at the shaft's upper end.



Large Krips-Mason Press, Designed for Making Washers.

An important part of the business of the manufacturers of this machine consists in the working up of scrap metal into washers. This size is capable of making from 4 to 5 tons of such washers per day. The machine is geared in the ratio of 8 to 1, the main driving gear having a diameter of 8 feet and 8 inches face. The flywheel weighs 1,800 pounds, the total weight being 25,500 pounds. The builders have received orders for 12 machines of this size within the past six months.

THE WHITNEY JACK FOR POLISHING AND GRINDING.

It is not so many years ago since it was believed that all it was necessary to do in fitting up a polishing room, was to provide a number of wheels of various sorts, mount them on crudely constructed stands, and connect them with belts to a jack shaft on the floor. Scores of such rude contrivances were grouped in small rooms whose atmosphere was charged with floating metal dust, and whose space overflowed with the men, work boxes, machines, countershafts and flying belts which were crowded together in it. One of the first improvements consisted in providing exhaust fans for the wheels, thus serving to remove the dangerous metallic dust which did such damage to the workman's lungs. Besides that, some recent installations have shown evidences of forethought in the matter of doing away with unprotected driving mechanism. One of the most interesting of these plans is that incorporated in the Whitney "jack" shown below. While this device is here described for the first time, it has been tested out in actual use for something over four years, some manufacturers having had as many as 100 of them going throughout that period. Its builders, the New Britain Machine Co., of New Britain, Conn., assert that a definite and adequate mechanical reason exists for every feature of its design, and that its details have been arrived at by trial, elimination, and the survival of the fittest.

One of the first points noticed is that the belting runs downward to a line shafting beneath the floor. By doing this, opportunity is afforded to dispense with countershafts, clutches and loose pulleys, and thus at the outset relieve those in

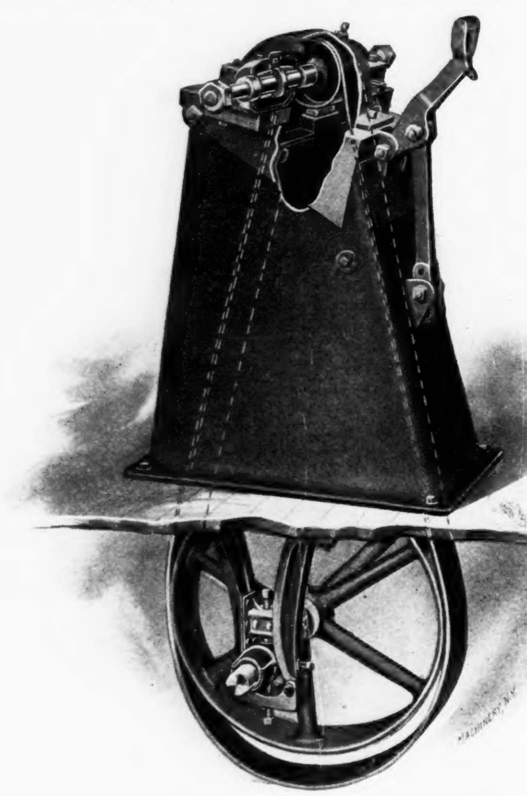


Fig. 1. Whitney Jack with Belt Slacked and Spindle Stopped.

charge of the machines of several notorious sources of trouble in high-speed machinery. This method of connection, pulling the shaft, as it does, down into its bearings, insures a steady true running wheel. The belt is carried inside of the case as shown by the dotted lines in Figs. 1 and 2. This entirely encloses it from its greatest enemies, oil and dust, and also protects the surrounding air from the currents which would otherwise be set up by the rapidly moving parts, thus lessening the amount of loose emery floating around in the air. The lever shown in the front of the machine is lowered in Fig. 2 and raised in Fig. 1. In Fig. 1 with the lever raised the spindle is dropped and the belt hangs slack, stopping the machine; this extends the working life of the belt and relieves both the bearings of the jack and those of the lineshaft

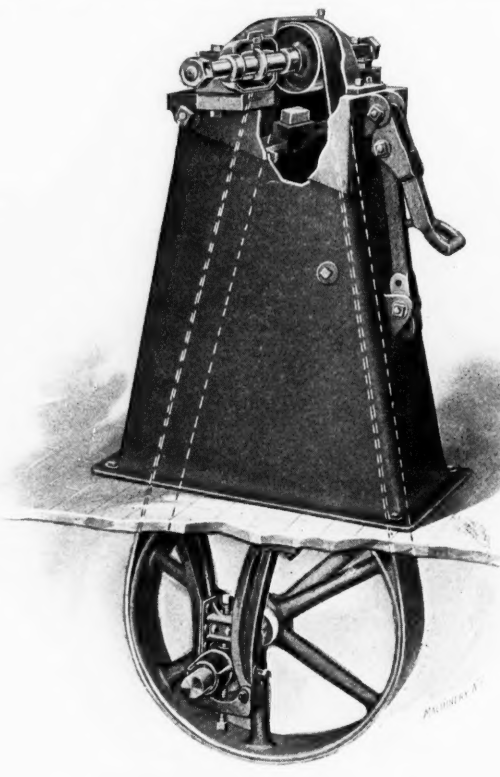


Fig. 2. The Head Raised to Working Position.

from the pressure due to the tension of the belt. When the handle is depressed the spindle is raised, as shown in Fig. 2, and the belt is in position for operation. It can be readily reached for examination, and provision is made for tightening it without relacing. The weight of the heavy wheels, bearings, etc., is usually enough to hold the top down at all times onto the starting handle, but when such work as sad irons are being polished, under the pressure of a lever beneath the wheel, an up-stop is provided to lock the top.

The spindle is of high carbon steel, with a special form of threaded end which tends to prevent the accumulation of emery at this point. The pulley is crowned according to the system in vogue in the shops of the builders, and described in a letter by Mr. Gauthier in the September, 1905, issue of MACHINERY. This system, in the belief of the builders, gives the maximum tractive effort at high speed, with a true running belt and a comparatively small amount of center stretch. A double seal is provided against the intrusion of emery in the bearings. The important matter of lubrication is attended to by a reservoir of oil for each bearing, this oil being used over and over again. Speeds up to 5,000 revolutions per minute have been attained and maintained on this machine. The table given below, furnished by the makers, will give a general idea of suitable speeds for wheels of various kinds and varying diameters:

Diameters.	12 in.	14 in.	16 in.	18 in.	20 in.
Solid emery wheels........	1750	1500	1315	1165	1050
Leather covered polishing wheels	2700	2320	2030	1800	1620
Disk grinders (steel disks)	2700	2320	2030	1800	1620
Cloth buffing wheels.......	3980	3410	2985	2655	2390

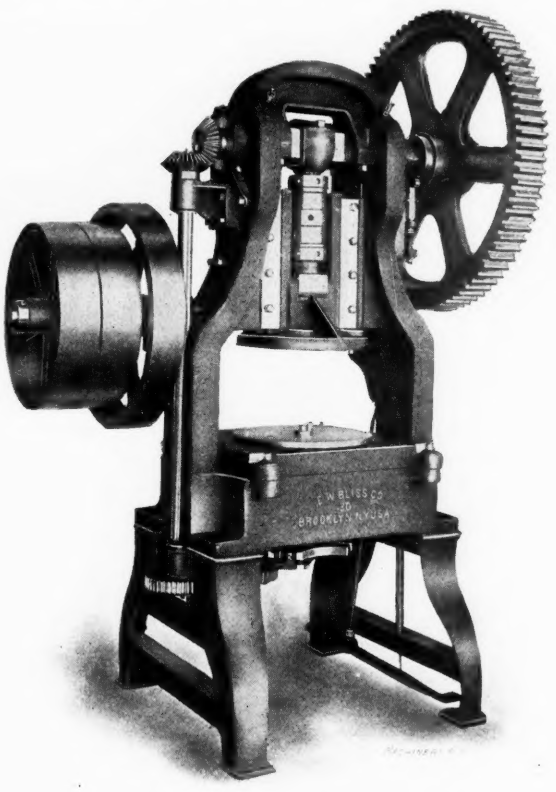
Any desired form of windgate or hood may be attached by the purchaser; the makers have patterns for a number of different styles of them.

BLISS SPECIAL DIAL FEED PRESS.

The principal interest of the machine shown in the cut lies in the feed arrangement. A bevel gear on the end of the crankshaft meshes with a gear on the vertical shaft at the

left hand side of the machine. This, in turn, carries a spur gear at its lower end which drives a similar gear beneath the bed of the machine, the latter being connected to the mechanism known as the "Geneva stop motion." This device is too well known to require detailed description. It will be remembered that it provides a means for indexing a shaft or dial rapidly and easily, and then locks it in position for a longer or shorter space of time before again indexing it as before. In this use of the mechanism a further positive lock is provided which renders the location of the dial absolutely positive.

The machine is operated in an interesting manner. A large flanged bottom face is provided for the slide. To this four



Cutting and Forming Press with Ingenious Feed.

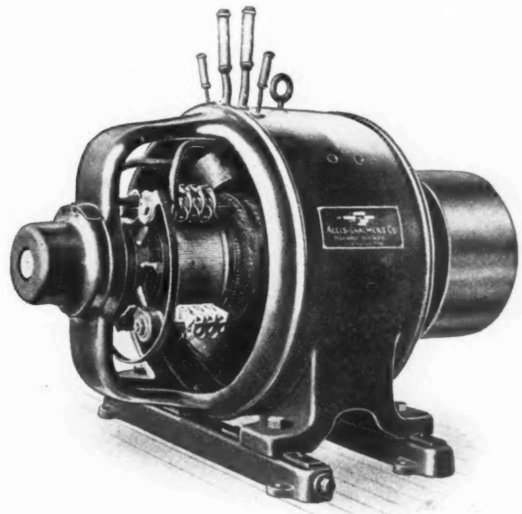
punches are fastened—a cutting and forming punch in front, and a similar cutting and forming punch in back. The dies are bolted to the dial plate. One operator stands in front and another at the back of the machine, each holding a piece of the material which is to be cut and formed. Passing the metal under the blanking punch, the blank is cut out and is then, by means of the dial plate, carried under the forming die, whence it is automatically ejected and brushed aside. Thus two duplicate pieces are produced at each stroke of the press, and since the machine runs at 60 revolutions per minute, the total product is 120 complete pieces per minute, involving 240 operations in that time. From this it will be seen that the machine is adapted for producing articles requiring a cutting and forming operation, when such articles have to be made in large quantities. The total weight of the machine as shown is about 6,200 pounds. It is built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y.

ALLIS-CHALMERS MOTOR FOR INDIVIDUAL DRIVE.

The Allis Chalmers Co. of Milwaukee, Wis., have recently developed a new type of motor for direct connected service; one of this line is shown in the cut herewith. The requirements for which this motor has been designed are those due to the growing application of individual drives to machinery of various kinds. Motors used for this service must not only be compact, but they must, as well, be adapted to mounting in any position, while the windings and commutator should be so arranged as to be partially or wholly protected from injury where such protection is required. Geared and direct coupled methods of driving are rapidly displacing belts, and this, together with the fact that strains and overloads are of common occurrence, requires larger bearings than are commonly used in motors of this class. Great improvements have also been necessary in the matter of commutating qualities, since present requirements call for wide variations in speed with occasional heavy overloads.

The field magnet yoke is of open hearth steel, machined to receive the bearing housings, which are held in place by through bolts and can be rotated through 90 or 180 degrees. The pole cores are of open hearth steel, circular in cross section, with pole shoes having faces of such shape as to give suitable distribution to the field flux, give good commutation, and prevent humming due to the armature teeth. The armature core is ventilated and the coils are form wound. The commutator is of large diameter to give a good wearing depth, with the mica between the bars so selected as to give an even wear. The shaft is lubricated by the ring oiling system. The projection for the pulley is turned down smaller than the journals, so that the latter may be trued up when worn without reducing their diameters below that of the pulley bore.

In the use of variable speed motors for the individual drive of machine tools, there are two points to be carefully considered: First, the size and weight of the motor is dependent to a great extent on the minimum speed at which the motor is required to develop its full rated power; the slower the minimum speed, the greater will be the size and weight for a given horsepower output. Second, the maximum speed of the motor is dependent on the allowable peripheral speed of th armature, commutator, and pinion or belt; or upon the ratio of speed reduction between the driven shaft and the motor shaft. This limits the maximum speed to 1,000 or 1,600 R.P.M. depending on the output of the motor. The maximum speed being thus fixed by mechanical limitations, any increase in the range of speed variation must be obtained by decreasing the minimum speed and consequently increasing the size



Allis-Chalmers Type K Motor.

of motor for a given output, or decreasing the output for a given size. These mechanical limitations make it desirable to keep the speed range down to a reasonable amount and in Type "K" motors it has, therefore, been limited to a ratio of 3 to 1.

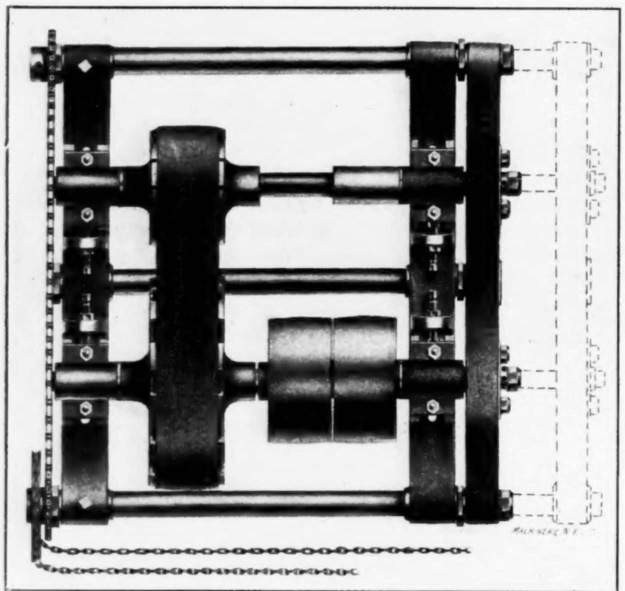
These motors are manufactured in thirteen different frame sizes, and for each size there are a number of ratings, the output of a given frame being proportional to the speed.

THE S. AND S. VARIABLE SPEED GEAR.

The S. & S. Engineering Co., 581 Park Place, Brooklyn, N. Y., are selling in this country the interesting variable speed device shown in the accompanying cut. This appliance has been built and used for a number of years in England and Canada, and is therefore not in any respect untried.

The device is of the expansion pulley type, so designed as to make possible an efficient short drive without depending on the sag and elasticity of the belt. Power is received by the shaft carrying the tight and loose pulleys. Both of the shafts are hollow and each contains a rod connected to the cross bar

shown at the right hand end. This cross bar may be moved in and out, between the two extreme positions shown by the full and dotted lines, through the action of two screws, located in the outer tie bars and connected to each other by the sprock-



Variable Speed Device, utilizing the Expansion Pulley Idea.

ets and chain shown at their left hand ends. Any suitable connection may be made for operating these screws in a convenient manner. The rods within the shafts have formed on their inner ends spiral grooves which engage with similar spiral keys in pinions seated within and concentric with the axis of the two expansion pulleys. Rack teeth are formed on the supporting arms of the separate sections of the expansion pulleys; these rack teeth mesh with pinions just described, so that, as the cross bar operated by the sprocket wheels and screws is moved in or out, the spirals on the end of the rods rotate the pinions, which in turn withdraw or extrude the sections of the expansion pulleys, in such a way as to increase the diameter of one and diminish that of the other. The change in velocity ratio thus obtainable is approximately 4 to 1.

No special belts are necessary, and all the pulleys used are between the bearings, thus at once economizing space and reducing the strain on the mechanism. This variable speed gear may be mounted on ceiling, wall or floor. The bearings are of the best phosphor bronze, and, excepting in the cases where the mechanism is installed on the floor, are all lubricated from magazine oil boxes which only require attention about once a month. The heaviest machines and those intended for floor positions are ring oiled. The horsepower transmitted by various sizes ranges from as small as 2 to as large as 128. The latter size employs 40-inch diameter by 24-inch face pulleys, running at a maximum speed of 120 revolutions per minute.

PRATT & WHITNEY 16-INCH TOOLMAKERS' LATHE.

The members of the line of lathes manufactured by the Pratt & Whitney Co., Hartford, Conn., have an individuality in their lines and proportions, and an originality in their mechanical design, which makes them singly, or as a whole, well worth the attention of the designer or the machinist. The latest addition to this line—a 16-inch toolmakers' lathe—is no exception to this rule, as our readers will admit after examining the accompanying halftones and following the description given below. Being designed for high class manufacturing, it must have all the improvements to be found in modern engine lathes, including the ability to take heavy cuts with high speed steels; and yet, since it is to be used for delicate work, the machine must still be sensitive in all its movements and convenient to handle. This is a difficult problem. Its proper solution requires a careful distribution of weight, and a proper proportion between the areas of the sliding surfaces and the pressure which has to be carried by them.

Of the two types built, the single belt gear-driven machine is shown in Fig. 1, while Figs. 2 and 3 show a 4-step cone-driven machine. The geared head is designed to give eight speed changes, obtained entirely by the action of friction clutches of sufficient power, manipulated by the three handles shown. This arrangement, while furnishing a powerful drive, still permits all the changes to be made while the lathe is running at full speed, even for the heaviest cut the tool is capable of taking. The highest and lowest speeds can be obtained instantly. When the motor drive is desired, a constant speed motor is mounted on the top of the headstock and geared to the pulley spindle. The spindle has bearings of unusual dimensions. Faceplate, chucks, etc., are attached to its nose by the well-known method employed by the builders, a taper seat being used in combination with a coarse pitch screw for drawing the parts together.

The feed and thread cutting changes are obtained by a rapid change gear mechanism which has 48 combinations, operated by the two knobs shown at the front of the gear box. A plate is here displayed giving tables and formulas for cutting irregular pitches, which may be obtained by change gears in the ordinary manner. When cutting threads it is not necessary to reverse the spindle, since the screw is reversed by the manipulation of the lower knob at the front of the apron. A

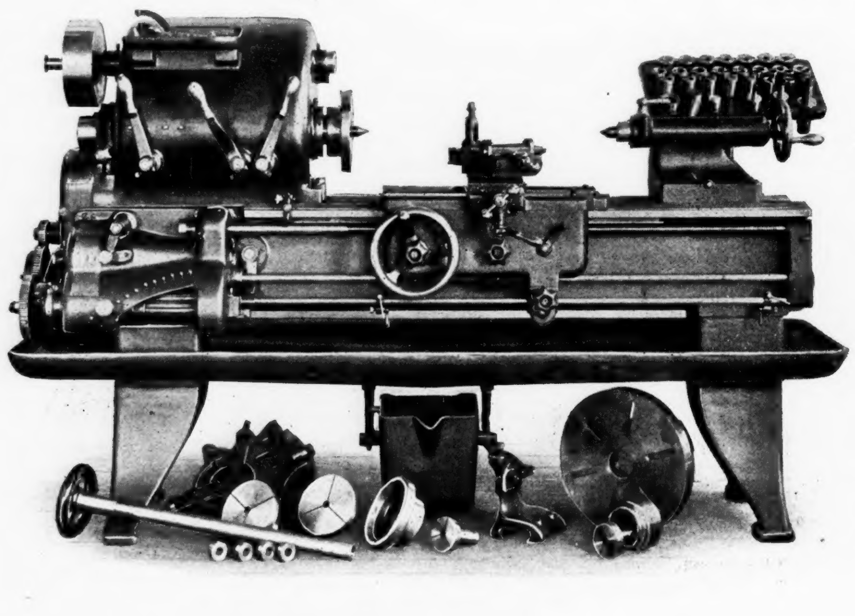


Fig. 1. Front View of Pratt & Whitney Single Pulley Gear-driven Lathe.

rod runs the whole length of the machine and on this are placed adjustable stops, so that an automatic cut-off is obtained in either direction for either thread cutting or turning. All feeds may be disconnected by turning the knob shown under the rear bearing.

A new feature of the lathe is the quick withdrawing mechanism provided for the cross slide. This is best shown in Fig. 3. Below the handle for the cross slide screw will be seen a short lever pivoted to a vertical axis. This lever is used in withdrawing the tool when threading, for either internal or external threads, the feeding in for the new cut being obtained by altering the adjustment of the cross slide screw in the usual manner. To bring the tool into engagement with the work again, the handle is thrown to the right-hand stop for external threads and to the left hand stop for internal threads. This movement is very rapid in operation and is thoroughly rigid, although sensitive and accurate. The compound elevating rest is also a new idea. The operator can set and fasten a thread tool, for instance, square with the

spindle, and then elevate it without loosening it in the toolpost.

The machine may be provided with a large variety of attachments. The taper attachment has only one sliding point in the whole mechanism, and can be adjusted without wrenches. The relieving attachment, best shown in Fig. 2, is especially efficient. In the tool board, supported back of the tailstock in Fig. 1, will be seen a set of expansion arbors and bushings which are very convenient for work which has to be exceptionally accurate. A series of collets for work up to 1¼ inch in diameter is also provided, while special step chucks may be used with short work up to 6 inches in diameter. Another attachment of great utility is the micrometer stop shown clamped to the front edge of the bed near the forward headstock bearings in Figs. 1 and 3. This is a great convenience in squaring up work to a given thickness. It may be used for either side of the carriage. Another use to which it may be put is that of bringing back the carriage without stopping the spindle when cutting threads. The half nuts are thrown out after the lead screw has been stopped on the lathe, and the carriage is brought back by hand against the stop; the half nuts are then thrown in, the stop being adjusted so that they will always catch the right thread.

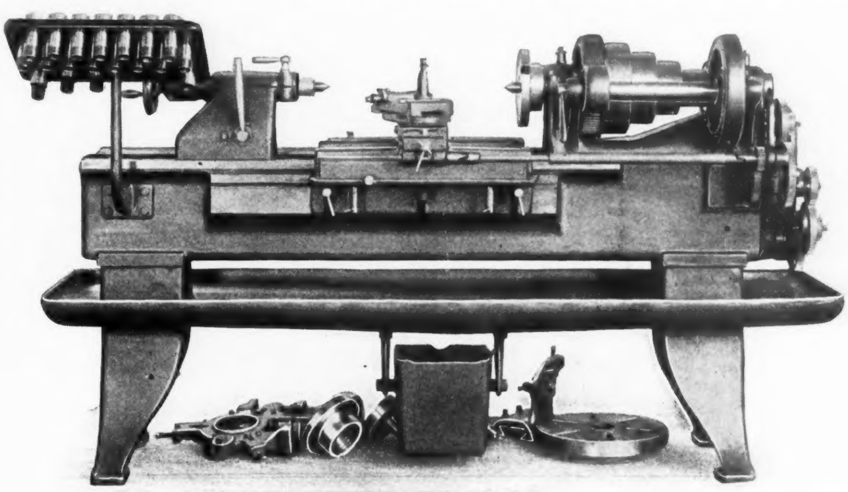


Fig. 2. Rear View of Pratt & Whitney Cone-driven Style Lathe, showing Relieving Attachment.

The general lines and proportions of the machine are familiar, since they follow those of the other lathes built by the same firm. The courageous use of unfinished surfaces wherever finished ones are not needed, and the rational and pleasing design of the larger castings, gives a combined effect

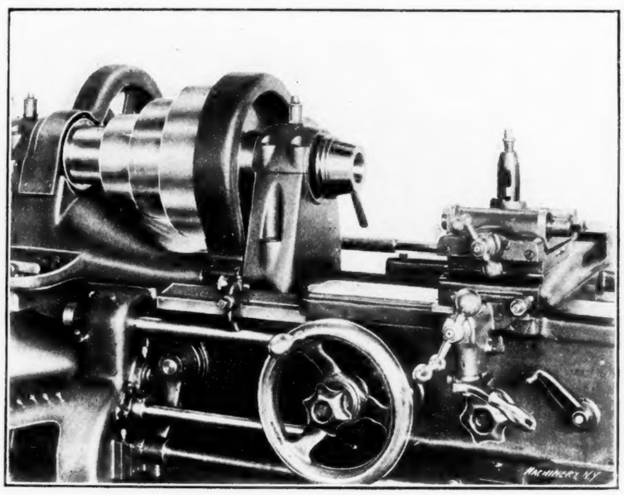


Fig. 3. Quick Withdrawing Mechanism, Micrometer Stop, Elevating Toolpost, Etc.

that to some eyes, at least, is as pleasant and satisfactory as anything built of iron and steel for commercial purposes can be.

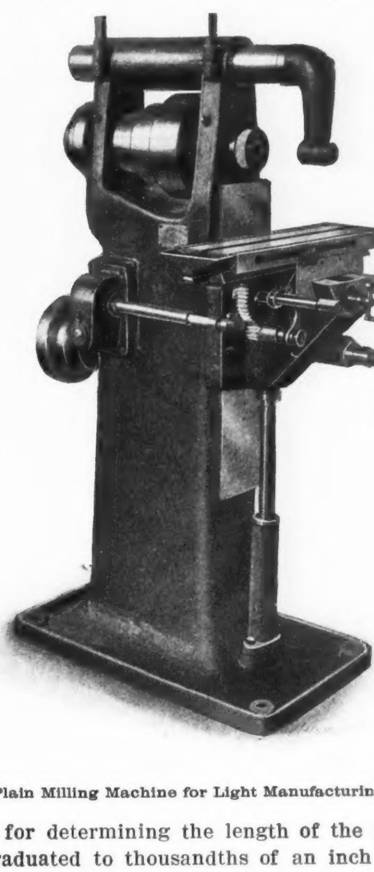
The lathe swings 16¾ inches over the V's and 10 inches over the cross slide. It is built in 6, 8 and 10 foot lengths. The lathe, as illustrated in the photograph, is provided with oil pan and tank, but it can also be furnished without these. An oil pump and piping will be furnished when desired. The lathe is also built with metric screws and metric gear boxes, though metric threads can be cut with English screws by using translating gears.

WAINWRIGHT & KELLEY PLAIN MILLING MACHINE.

In the plain milling machine shown in the cut, Wainwright & Kelley, of Trenton, N. J., have designed a tool to fill the requirements of makers of electrical goods, sewing machines, brass goods, and other manufacturers requiring a machine of medium range, but of great stiffness and accuracy. Besides the qualities just enumerated, attention has been given to reducing the amount of mechanism required to the lowest degree, so that the machine, as may be seen from the cut, is one of extremely simple construction.

So far as the main outlines of the tool are concerned, it conforms to the standard column and knee type. The column is very heavy for its size, and is so designed as to effectually absorb the vibration set up by the cutter. The knee is of the enclosed box type, reinforced to withstand side strains, and with an ample bearing on the column face.

The spindle is of hammered crucible steel 0.40 carbon, running in self-centering adjustable bronze boxes. The arbor hole is fitted to a No. 9 Brown & Sharpe taper. The arm is 3 inches in diameter and carries an arbor bushing of hard bronze, also adjustable for wear. The table has a working surface of 25 inches x 6 ⅛ inches, with a central T-slot and suitable pockets and channels for taking care of the cutting oil. The feed is operated through a rack and pinion, driven by worm gearing enclosed in the casing at the left of the machine. A quick return is provided. The feed is driven through a patented clutch, designed to be operated by an ad-



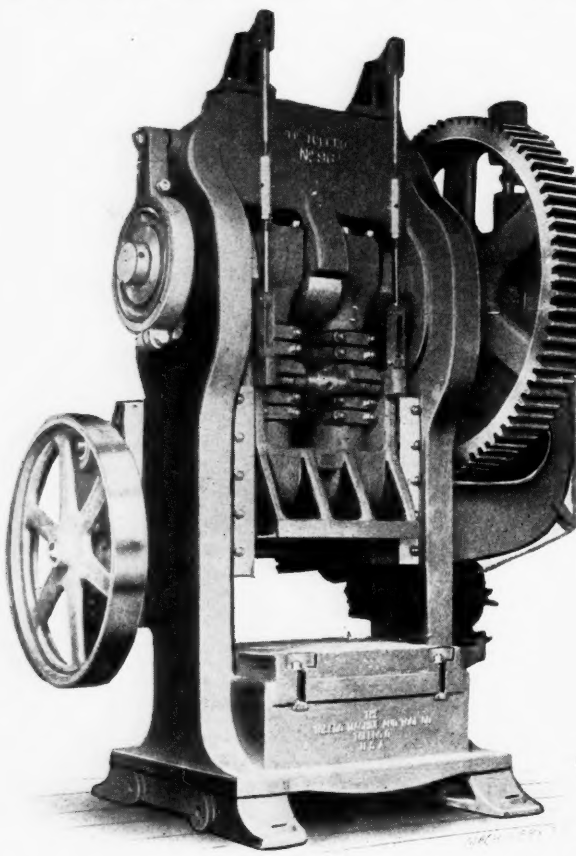
Plain Milling Machine for Light Manufacturing.

justable dog for determining the length of the feed. Adjustable dials graduated to thousandths of an inch are provided for the vertical and transverse movement of the table.

The lengthwise cross, and vertical movements of the table are, respectively, 18 inches, 4½ inches and 13 inches. The three-step cone is driven by a 3-inch belt. The net weight of the machine is about 1,100 pounds.

TOLEDO DOUBLE BACK GEARED PRESS.

The machine shown in the halftone below was designed for the hot pressing and forming of couplings for oil pipes and similar work, as well as for cold pressing. It is double back geared, has a double pitman, and is motor driven. The frame is a one-piece casting weighing 29,000 pounds. The clutch

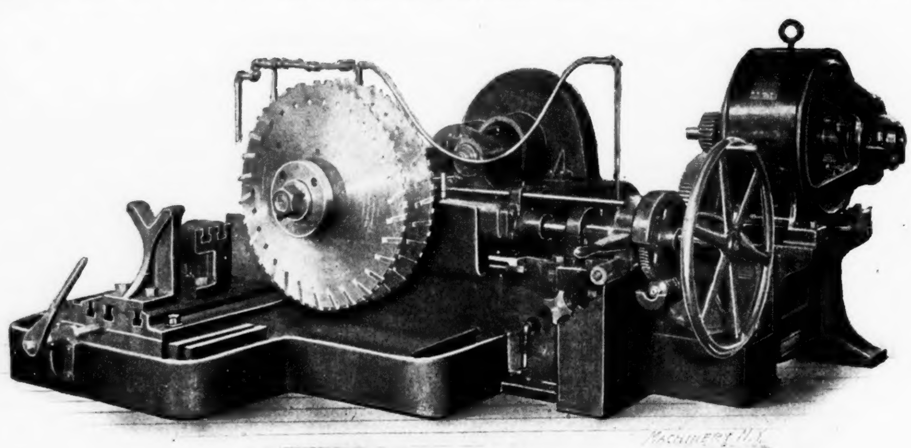


Toledo Double Back Geared Press.

mechanism is of the three-engagement automatic block type with gravity releasing device—a form specially suited for heavy presses, it being very powerful as well as simple in construction and positive in action. The 20-horsepower motor used is conveniently placed on the right hand side at the rear. The crankshaft is 9 inches in diameter. The large gear is 85 inches in diameter by 12 inches face; the flywheel is 60 inches in diameter, while the distance from the floor to the top of the large gear is 11 feet 8 inches. The distance from the bed to the slide, with stroke and adjustment up, is 30 inches, the length of stroke being 8 inches. A bed area of 6 inches right to left by 48 inches front to back is provided. The total weight of the machine is 73,500 pounds. It was built by the Toledo Machine and Tool Co., Toledo, O.

MOTOR-DRIVEN ROTARY SLOTTING MACHINE.

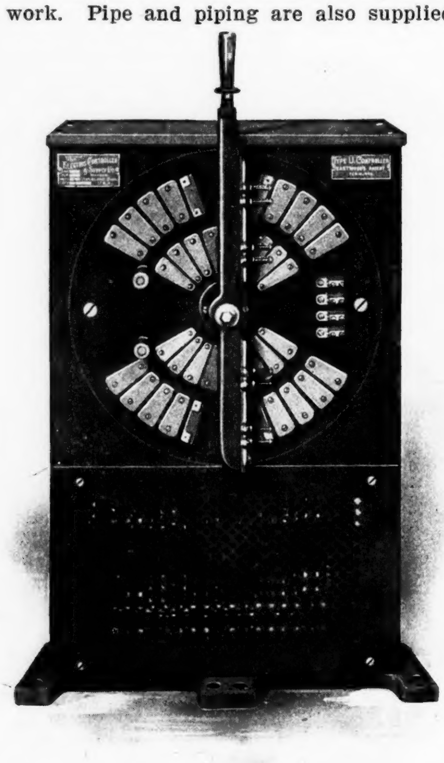
The halftone shown herewith illustrates a specialized form of cold saw, recently built for the Union Pacific R. R. Co. by the High Duty Saw & Tool Co., of Eddystone, Pa. It consists essentially of two saws mounted on the same spindle at adjustable distances apart, together with means for setting the saws into the work which is held by suitable clamps and fixtures on a table prepared for it. The machine is intended to be used in slotting forged steel cranks, connecting rods, links and similar pieces. By removing one of the saws it can be used as a regular cut-off machine on axles and miscellaneous straight stock.



Cold Saw for Slotting Cranks, Connecting Rods, Etc.

The machine is electrically driven by a 15 H.P. direct current motor, having a speed change ratio of two to one. The connection between the motor and the saw spindle is by positive gearing of the spur and bevel type, it being the belief of the makers that worm gearing is unsuited for this purpose, owing to its high friction loss and the wearing out of the costly wormwheels. The slide on which the saw is carried has a large bearing area on the table and is made with the underlock cast solid. Phosphor bronze taper shoes take up all the wear on the saddle or table.

A removable table with a screw adjustment for setting work in line with a spindle, is a feature of the machine. Special V stands and rest blocks with suitable clamps and bolts are provided; these fixtures are all removable, leaving the table clear for bulky work. Pipe and piping are also supplied for pro-



A Controller Specially Designed for Crane Service.

viding the saws with lubricant. The machine will cut double slots to a depth of 11 inches and spaced up to 10 inches apart, in steel as hard as 0.45 point carbon. The machine in ordinary service cuts a slot of these dimensions in fifteen minutes.

A NEW LINE OF CONTROLLERS.

The Electric Controller & Supply Co. of Cleveland, Ohio, have recently completed the design of a line of controllers with a rating of from 1 to 50 horsepower. This line they have designated as their "Type G." These controllers are built to meet the requirements of general crane service where the conditions are not severe enough to demand the use of

the Dinky ventilated style. Besides being mounted and used in the ordinary way in cases where the crane has a cab and permanent attendant, they may be arranged with spring return for operation from the floor, by means of pendant ropes or chains. This construction is designed to meet the requirements of crane users who have decided that cranes no larger than 15 to 20 tons capacity, with 25 to 30 horsepower motors on hoist and bridge motion, may be operated from the floor by any of the men in the shop, thus saving the wages of a crane operator who would probably be idle half the time. When used in this way, special cut-outs are arranged for the current at the end of the trolley run and at either end of the crane track.

Type "G" controllers are self-contained, compact and accessible. They are all made with jigs, fixtures and other special tools which make their parts interchangeable. The segments are of copper, screwed to brass lugs, to which all wiring connections are made; this allows the contact segments to be removed and replaced without disturbing the wiring. The contact fingers, of drop forged copper of great hardness, may also be removed and replaced without removing the contact arm. An effective blow-out is provided in all sizes.

A DOUBLE PULLEY LATHE OF LARGE CAPACITY.

The machine shown in the halftone is a specialized lathe built for machining pulleys up to 8 feet in diameter by 72 inches face; the machine is double and it will finish two such pulleys at a time. The spindle is driven by a large wormwheel keyed to it midway of its length, the worm being driven by a 40 horsepower motor. Each end of the spindle carries a faceplate for supporting and driving the work. To the extended base on either side are clamped two tailstocks, adjustable in or out to suit the length of the arbor used when the pulleys are turned on centers. The machine is open at the back so that pulleys can be swung in without meeting any obstruction.

Two toolposts are used on each side. They are held by slides which have a longitudinal power feed on the cross rails. These cross rails are supported by the permanently fixed brackets shown, and may be moved in or out on them by means of adjusting screws at each end of each rail, each pair being connected together by bevel gears and a transverse shaft, operated by a ratchet lever. This adjustment is not used in feeding, the rail being moved in or out to roughly suit the diameter of the pulley; the depth of cut and the facing of the rim are regulated by a cross feed in the tool rest. The feed of the two toolposts on each rail, lengthwise of the pulley, is positively operated by the gearing on the outside end of each cross rail. An automatic crowning device is used whose guide bar may be seen mounted on the front edge of the cross rail. This machine was built by the Pittsburg Machine Tool Co., Allegheny, Pa., and weighs 50 tons.

* * *

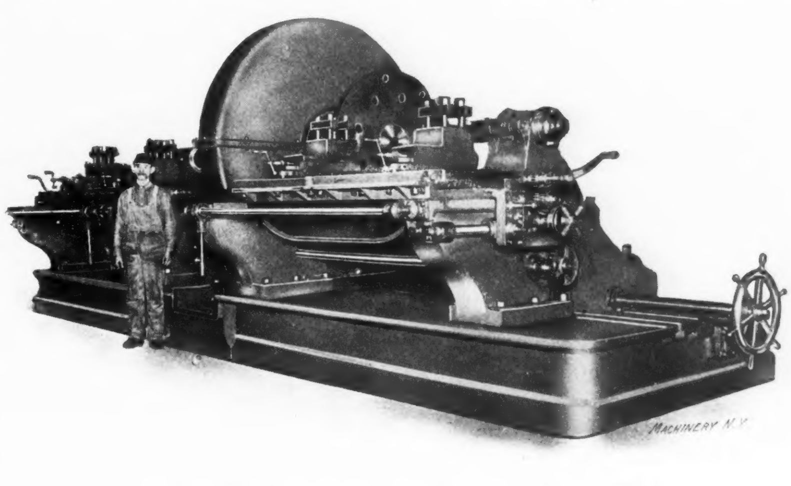
Secretary Taft has just rendered his decision upon the applications under the Burton Act for the issuance of permits to divert water for power purposes from the Niagara Falls on the American side, and for permits to carry electrical current developed from water power on the Canadian side into the United States. The Secretary decides that with the diversion of 15,600 cubic feet per second on the American side and the transmission of 160,000 horse-power from the Canadian side, the scenic grandeur will not be effected substantially or perceptibly to the eye. If Mr. Taft's contention in this respect is correct there is, of course, no objection to making use of the enormous power of the falls, but it must be remembered that there is nothing that can be considered to belong to the nation as a whole any more than do these water falls. It is deplorable that their exploitation will in all likelihood merely be profitable to a few corporations of more or less monopolistic nature, instead of enriching the nation as a whole, which would be the correct and the desirable end of their conversion into industrial use.

EUROPEAN INDUSTRIAL NOTES.

TRADE CONDITIONS IN GREAT BRITAIN.

Present indications point to a continuance, during 1907 at least, of general briskness in trade. The returns of exports and imports recently issued record a period of unexampled expansion of British commerce during 1906. It has, however, recently been pointed out that the increased prices of most raw and semi-finished materials cause a certain dislocation of general values, and if great caution is not exercised a big output at high prices will not necessarily show greater net profits than a smaller output when medium, all-around prices prevail. The price of copper, for instance—about 25 cents per pound in January—hits many manufacturers very hard, as prices for their products cannot readily be raised in the same ratio. Similarly, one daily newspaper notes that the ordinary "man in the street" finds little increase in salary or wages. There is, of course, greater steadiness in the unskilled and semi-skilled labor market, but the skilled artisan finds a wage advance of from 25 cents to a dollar weekly about as much as he can reckon on, while the clerk in general simply deals with larger figures in his books but feels no personal benefit. At the same time, increased prices of food, rents, etc., pretty well balance current salary or wage advantages. Perhaps it is well to occasionally take some cognizance of such aspects of industry.

Practice changes or advances so rapidly nowadays that it is difficult to realize that it is scarcely more than nine years ago that the question of relative merits of cast *versus* cut gears was being discussed with some little dogmatism in this country. The matter was somewhat complicated by the fact that cast gears of such general truth and finish that they were easily equal or superior to many specimens of what purported to be cut gears, could, over here, be obtained without any particular difficulty. The argument of the extra strength and endurance of cast teeth which retained their hard skin was freely brought forward, but for some years now the many indirect advantages of cut gears, coupled with the considerable diffusion of modern types of gear cutting machines, and the force of customers' demands, has practically made the use of cut gears on machine tools, and many other machines, universal. Several firms have laid themselves out with a direct view to meet the large demand thus created, and in this connection we may make mention in particular of David Brown & Sons, Huddersfield, who, as a development from a well-established business of general pattern making, have gradually added gear making and cutting to such an extent as to necessitate the building of a large and modernly designed and equipped works solely for the latter purpose, large gears and speed reducing gears in general being rather a specialty with them. Smaller concerns also make a good showing and find their plants well employed. American makes of automatic gear-cutting machines early obtained a strong footing, due partly to their intrinsic merits, being first in the field, and to being generally of thoroughly high



Double Pulley Lathe built by the Pittsburg Machine Tool Co.

grade workmanship. Several British makers, of which Darling & Sellars, Keighley and Parkinsons, Shipley, are representative, are now turning out machines giving a high output—on British gray iron—coupled with designs which appear likely to ensure extended satisfactory life. The hobbing of spur gears is also making some progress, Continental makers being prominent in offering machines adapted to this method of production, though John Holroyd & Co., Manchester, are also turning out machines capable of handling gears up to the largest diameters in general use. Concerns who have given attention to bevel gear planers include Smith & Coventry, Ltd., Manchester, and Greenwood & Basley, Ltd., Leeds.

Drilling machines of all kinds have, during the last few years, received considerable attention. Not only has the general standard of strength, power, and handiness been raised, but one or two new types have been evolved. Messrs. Archdale, of Birmingham, have been active in the design and production of small radial drills from 30 inches radius upward, which combine the advantages of the upright drill press with the range of a radial. They are efficient both as sensitive drills and as exponents of the possibilities of high-speed twist drills. Their success has induced sincere praise. In the medium and heavy lines of radial and upright drills many good examples may be quoted both of the all-gear and cone pulley drive types. Among typical makers may, perhaps, be mentioned Kendall & Gent and Hetherington's, Manchester; Swift, Halifax; Buckton, Leeds; Shanks of Johnstone, etc., Features which not very long ago would have been considered as pandering to indolence or ultra-refinement are now included almost as commonplace. The medium and sensitive types of upright drills have not been neglected, several concerns now turning them out on lines suggested by the best American practice, and in design, finish, and price they are able to compete on level terms with any other build.

Agricultural engineers have recently considerably strengthened their position as regards ability to compete in neutral markets, special attention being paid to the requirements of foreign users. At present many designs are probably on the heavy side rather than the light, but it must be remembered that a very good market exists in this country for substantially built machines which are properly used and kept by the owners and care is being taken not to spoil one market in efforts too keenly directed toward gaining others.

Shipbuilding capacity in Great Britain, both from the mercantile and naval standpoint, has greatly increased during the last few years. Large Sheffield ordnance makers have acquired shipbuilding facilities, and, similarly, shipbuilders have working arrangements with complementary firms, so that warships may be constructed and equipped throughout by contract with a single company. The speed of building ships has been remarkably accelerated, both in government and private yards. The government especially has been active in improving its engineering and shipbuilding equipment. The first keel plate of the new battleship *Temeraire*, of the *Dreadnought* class, was laid down at Davenport on January 1 of this year, the ceremony being of an absolutely private character. Important extensions and improvements are now being effected at the Elswick shipyards and works and also at the Openshaw (Manchester) works of Armstrong, Whitworth & Co. The shipyard is being entirely remodeled, with a view to the construction there of the heaviest armor-clads, such as the present naval policy foreshadows will be adopted by all great naval powers in the future. Several of the building berths are being lengthened and improved and, most important of all, an entirely new armor-clad berth is being put down at the east end of the yard to take vessels up to 700 feet long and of the heaviest displacement. The new berth which will be used for the construction of the *Superb*, one of the three new *Dreadnoughts*, which is to be built by Armstrong, Whitworth & Co., will be able to carry a vessel of over 30,000 tons, which is nearly twice the launching weight of either the *Lusitania* or the *Mauretania*, the largest vessels yet built. JAMES VOSE.

Manchester, January 25, 1907.

[Last year the tonnage of ships launched in British yards reached the total of more than 2,000,000 tons, which is the highest on record.—EDITOR.]

MISCELLANEOUS FOREIGN NOTES.

THE OBERSCHLESISCHE EISENINDUSTRIE A. G. in Germany have decided to introduce the manufacture of tool steel in the electric furnace on a large scale. The Kjellin inductive furnace will be used; the installation will be made by the Siemens & Halske A. G., Berlin, Germany.

J. PARKINSON & SON, Shipley, England, have placed on the market a new horizontal boring machine. The bed is 15 feet long over all; the spindle is 4 inches in diameter, and bored to receive a No. 6 Morse taper; sixteen spindle speeds are obtainable and eight rates of gear feed, ranging from 0.012 to 0.25 inch per revolution of spindle. The work table is 3 feet by 4 feet. The maximum distance from the top of the table to the center of the spindle is 32 inches, and the minimum 3½ inches. The machine is driven by a 4-inch belt applied to a four-speed cone.

THE WOLSELEY TOOL AND MOTOR CAR CO., LTD., Birmingham, England, have placed on the market a boring machine head having two spindles for use in boring twin cylinders and work of similar requirements. The centers of the spindles can easily be adjusted in relation to one another. One spindle is driven direct from the boring machine by a suitable coupling, while the other is driven by a train of gears. The maximum center distance is 6, the minimum 4 inches. Scales in the front of the head give the exact center distance obtained by any one setting.

GERMAN EXPORTS AND IMPORTS OF MACHINE TOOLS. For the nine months, January-September, 1906, the exports of machine tools from Germany amounted to 33,000 tons, of which somewhat more than 500 tons were exported to the United States. The imports amounted to 7,100 tons, most of this, or nearly 5,000 tons being American machine tools. There is some hope in Germany that some tariff arrangements will be effected with the United States so as to, in the future, even out the balance of exports and imports of machine tools in regard to this country to a greater extent than at present.

THE NEW ZEALAND EXHIBITION.—The Christchurch Exhibition which was opened during the latter part of last year has been well patronized, steamers from Australia having brought over very large numbers of visitors and business men. America's interest in the exhibit has been exceedingly small, which probably is due to the fact that there is at present no pressing need of new markets. In the future, however, it is likely that New Zealand and Australia will both become of importance to American trade, particularly after the opening of the Panama Canal, when the trade in Australia from the eastern part of the United States is likely to receive a great impetus.

THE OWNERSHIP OF MACHINERY IN FACTORIES IN GERMANY.—We mentioned in our foreign review last month that the consular reports from Germany indicated that the imperial court held that machines in a factory became fixtures and could not be claimed by the firm having furnished them, no matter what would be the particular condition of sale in each individual case. We also mentioned that this ruling caused great excitement in Germany and that there was a great deal of opposition. On the other hand later reports put forth the other side of the question. It is stated that the easy way in which machinery can be obtained in Germany, when being sold on the installment plan, causes the springing up of factories which have no reason for their existence, or as the report puts it, not the least right to exist. It is a common occurrence that people without a cent of capital and lacking the slightest knowledge of the trade in which they engage start a factory by obtaining the necessary machinery and plant equipment on credit. Such manufacturers are not competent to conduct the business in which they have engaged. They sell the manufactured goods at prices impossible for continuing the enterprise. Then the inevitable bankruptcy takes place and the owner of the machinery, if he is protected by a contract of sale, takes away his machinery on which he may have already received half or more of the price by installment payments. Other creditors of the firm in bankruptcy are thus so much heavier losers. This is the reason why the court has held it necessary to rule in the interest of all concerned and to thus discourage the practice of installment plan selling which at best is a poor way of selling machinery.

OBITUARY.

Willard LeGrand Bundy, inventor of the Bundy time recorder, died at his home in Syracuse, N. Y., January 19, at the age of 61. When a young man he learned the jeweler's trade in Auburn, N. Y., and in 1870 he went into the jewelry business for himself, which continued until 1889 when he removed to Binghamton, N. Y. While at Binghamton Mr. Bundy invented the first time recorder, and was one of the organizers of the Bundy Mfg. Co., of that city. In 1903 he removed to Syracuse and entered the employ of the W. H. Bundy Recording Co. Mr. Bundy was the inventor of the Columbia calculating machine, brought to a state of completion just prior to his death.

JOSHUA STEVENS.

Joshua Stevens, for many years president of the J. Stevens Arms and Tool Co., Chicopee Falls, Mass., and inventor of the Stevens single-shot pistol and rifle, died in Meriden, Conn., January 21 at the age of 92. Mr. Stevens was born in Chester, Mass., September 10, 1814, and was apprenticed in a small shop in that town in 1834. He had a most interesting experience as a mechanic, and in October, 1894, an article entitled "Sixty Years as a Mechanic" was published in MACHINERY, giving an account of his varied experiences. His early life was one of pinching poverty and long hours. He worked for $1.00 per day from 5 in the morning until 7 at night, knocking off only half an hour for breakfast and dinner. In 1837 he states in his reminiscences, flour was $11.00 per barrel, nails 7 cents per pound, and other common commodities in proportion. The modern pistol and rifle began to be evolved in 1838 and in that year Mr. Stevens went from Chester to Springfield, Mass., to work for Mr. Cyrus B. Allen, who had a small gun and pistol shop. He was afterwards associated with Mr. Harvey Waters at Stafford, Conn., and helped him turn out the first pin machine made in the United States. He later met the celebrated Col. Samuel Colt, the inventor and manufacturer of the famous Colt's revolver. Mr. Stevens is credited with having had a great deal to do with this successful development. The J. Stevens Arms and Tool Co. was started in the early 60's and in 1865 the company began the manufacture of machinists' tools, at first making a spring caliper. The tool business was discontinued in the 90's, and attention confined to the gun and pistol business, until later, with the advent of the automobile, a department was organized for this line. Although Mr. Stevens severed his connection as president of the company in 1896 he still retained an interest in its welfare and made frequent visits to Chicopee Falls, as his health permitted.

JOSEPH FLATHER.

Joseph Flather, president of Flather & Co., Inc., Nashua, N. H., died at his home, February 3, of a valvular disease of the heart, aggravated by a slight attack of pneumonia. Although in failing health for the past three or four years his death at this time was unexpected.

He was born in Bradford, England, April 1, 1837, and received his education in the common schools of that city and of Norwich, to which city his parents had moved. At the age of eleven he entered the repair shop of a large mill in Norwich and continued there for one year, when his parents again removed to Bradford. Here he was apprenticed to his uncles, William and Henry Hodgson, manufacturers of worsted machinery, and continued in their employ for about seven years. At the age of nineteen, his term of apprenticeship having expired, he, with his father took passage on a sailing vessel for Philadelphia, where they landed, after a tedious voyage of six weeks, in September, 1856.

Being unsuccessful in finding employment in or around Philadelphia they made their way to Harper's Ferry, W. Va., where relatives were located. On account of unusual ability with the file he secured work filing gun-sights at the Government Arsenal at that place. Afterwards he went to Zanesville, Ohio, to work in a railroad repair shop but soon returned to Harper's Ferry. In 1859 he went to Nashua, N. H., and entered the employ of Chase & Co., manufacturers of sewing machines. He continued there until the Civil war broke out

Joseph Flather.

when he secured contract work in gun factories in Binghamton, N. Y., Yonkers, N. Y., Trenton, N. J., and Bridgeport, Conn.; while at the latter place he worked on the tools used for the manufacture of the Henry repeating rifle, the first of its kind used by the Union troops.

At the close of the war Mr. Flather, with two brothers, moved to Parkersburg, W. Va., and established a shop for the manufacture and repairing of oilwell tools, but the venture was a failure owing to the habit of the oilwell proprietors combining business with pleasure; instead of trading near home, they would take a holiday and spend their money in Pittsburg and other cities. Returning to Nashua once more, in 1867, he, with his brothers, Edward and William J., formed a partnership with the late J. K. Priest, who at that time manufactured sewing machines but who later established himself, under the title of the American Shearer Co., as a manufacturer of clippers of all kinds. It was the idea of the Flather brothers and Mr. Priest to manufacture not only sewing machines but lathes, but the lines were so dissimilar that the partnership was soon dissolved, the Flather brothers taking over the lathe department. It was at this time that the firm of Flather & Co. came into existence, Joseph and William J. being the active partners and Edward the silent one. Times were very dull and business scarce, and the success of the firm hung in the balance for many years. After several changes in location and with varying success the firm built a wooden shop on the site of their present building. This building was destroyed by fire September 29, 1876. Everything was destroyed and the loss was total, excepting two or three thousand dollars insurance. With this money the shop was rebuilt on the same location but this time with brick, the wisdom of this being shown in the fact that this building is still a section of the present works. In 1876 the concern exhibited their lathes at the Centennial Exhibition held in Philadelphia, and it was here they secured their first foreign business, their lathes having attracted the attention of manufacturers from Eskilstuna, Sweden, and Frankfort, Germany. This small beginning paved the way to what has proved to be a large and profitable foreign trade, extending further and further until now it includes every country where machine tools are used. During all the "panic" years up to 1879 the firm had great difficulty in making both ends meet and only succeeded by the greatest economy and perseverance and the willingness to do anything, including job work, special machinery and even making two-wheeled velocipedes, the forerunner of the later safety bicycle. After the panic years matters took on a brighter look and early in the 80's the firm was established on a sound basis and began to enlarge. With continued prosperity more additions were made until the present size was obtained, beyond which Mr. Joseph Flather had no ambition to go, although several times business conditions would justify further increase. In 1885 Mr. Flather invented the "patent feed" so called, which was the first successful effort

in placing the rod and screw on the front of the lathe so that either could be driven by both belt and gears. He also invented many other improvements of consequence. In 1901, the partnership existing between the brothers, having expired, Mr. W. J. Flather withdrew and the company was incorporated under the title of Flather & Co., Inc., with Mr. Joseph Flather as president and treasurer, which office he held at the time of his death.

Mr. Flather was widely known, in his adopted city and among the manufacturers of machinery. He took pride and comfort in his family, making them his confidants in all personal and business affairs, and it was with them that he consulted rather than with friends. He was especially fond of reading, and had traveled extensively both in this country and Europe. He served his ward in both branches of the city government; he also served a term as representative to the General Court (State Legislature). For ten years he was a member of the board of education, the last two of which he acted as its president. When the National Machine Tool Builders' Association was formed in 1901 he was honored by being selected as its first president, which office he held for two years. He is survived by his wife and seven children, among whom are Mr. F. A. Flather, treasurer Boott Mills, Lowell, Mass., and H. L. Flather, superintendent Flather & Co., Inc.

HENRY CLARK SERGEANT.

Henry Clark Sergeant, of the Ingersoll-Sergeant Drill Company—now an integral part of the Ingersoll-Rand Company—died at his home, Westfield, N. J., January 30, seventy-two years old.

Mr. Sergeant was of world-wide repute as a prolific and highly successful inventor, especially in the line of rock drills, air compressors and mining and excavating machinery in general, his active life having been coincident with the period of development of the modern and phenomenally efficient apparatus now so universally employed and with such industrially revolutionary results, he having been a leading and constantly active agent not only in the line of invention and improvement but also in the devising of the details and the means of precise and economical manufacture.

Mr. Sergeant was born at Rochester, N. Y., but his earlier years were spent in Ohio. He was of uncurbable activity, both physically and mentally, from the beginning. He had only a common school education and was working in the machine shop at a very early age. His inventive faculty made work for itself from the first. He quickly began to see the undeveloped possibilities of systematic manufacture by the aid of special machinery. His first practical application of his theories was to the making of the spokes, hubs and felloes of wagon wheels. He designed special machines for this work and at the age of eighteen he accepted a contract for manufacturing wheel parts in quantity. In this he was so successful that in two years he was taken into partnership by a firm manufacturing wagon wheels.

The routine of the factory, however, could not hold him, and after severing this first business connection, the next six years of his life were spent in various pursuits, chiefly commercial, in which he met with varying success. He was a ready speaker, though not known as such in later years, and found favor as a lecturer. He had figured for a time also as a champion skater. He still found time and opportunity in the line of invention and the development of labor saving machinery. His first United States patent, issued when he was nineteen, was for a boiler feed. Succeeding patents suggest the range of applicability of his inventive faculty. In December, 1858, he patented a steam engine governor. This was in fact a governor for marine engines to prevent their racing to destruction when the wheels were out of water. This was soon after adopted by the U. S. government and applied to the warships of the period. He had after that patents respectively for gas regulators, for steam pumps, four for steam boilers, five for brick machines, a fluting machine, six for water meters, all these before he had struck what must now be considered his life work.

Three of the brick machine patents were issued in 1867 when he was a resident of Columbus, Ohio, but soon after that

Henry Clark Sergeant.

he started a machine shop of his own in New York, building a wide variety of machines and developing many crude ideas into practical working successes. In the early seventies hither came Simon Ingersoll with the drawings for the first Ingersoll rock drill, a then untried device. The possibilities and the large future for the rock drill particularly attracted Sergeant. None can say now how much he contributed to the development and success of the original Ingersoll drill, but at least one patent was issued to Ingersoll and Sergeant as joint inventors. The Ingersoll Drill Company was formed and introduced the drill in the rock excavating fields.

Although the drill was at first operated only by steam, its advantages when driven by compressed air and the absolute necessity of using air for mine and tunnel work turned Sergeant's attention to the improving of the design and details of the air compressor, which the Ingersoll Company began to market in connection with the drills and for other incidental uses which began to develop. He was soon working with all his energies in both lines and constantly bringing both the drill and the compressor into higher efficiencies. As the business grew the partnership of Sergeant & Cullingworth was formed with shops at 22d Street and Second Avenue, New York.

The water meter patents spoken of were issued during these early business years in New York, and in this line he was in touch with José F. De Navarro, two patents issuing to the latter as joint inventor with Sergeant.

Again turning from the task of manufacturing, Mr. Sergeant's interest was sold to the Ingersoll Drill Co., and he went to Colorado to put into practical operation some of his mining methods. He operated a silver mine for a time, but, fortunately we may now say, it was not a success. Meanwhile he had developed another complete rock drill with an entirely novel valve motion. Two patents on this drill are dated 1884. He brought his new drill East in 1886 and formed the Sergeant Drill Company, which began building the drill at Bridgeport, Conn. Two years later the new company joined hands with the Ingersoll interests and the Ingersoll-Sergeant Drill Company was formed with Mr. Sergeant as its first president. The new company's shops were at 9th Avenue and 27th Street, these shops having been occupied for a short time previously by the firm of Sergeant & Cullingworth which then went out of existence, Mr. Sergeant's interest in this firm having terminated before he went to Colorado. Mr. Sergeant remained at the head of the company but a short time, he then disposing of the bulk of his interest. A considerable time was then spent in London and Paris. He returned to the rock drill business, this time as a director in the Ingersoll-Sergeant Company, with the purpose of devoting all his time to invention in the interest of the company. He labored constantly in developing and improving the company's products and in spreading their application into new and wider fields, his most notable inventions being the Sergeant "auxiliary" and "arc" valves, "tappet" rock drills, the Sergeant "release rotation"

for rock drills and the "piston inlet" valve for air compressors, all of which are in general and successful use to-day. He was also the originator of many new ideas in stone channeling, coal undercutting and associated lines.

In the days of the Sergeant & Cullingworth Company, in response to the solicitations of the management of the Third Avenue Elevated Railroad Company, of which he was then a director, for a device which would protect them from the constant losses accruing from the repeated use of uncancelled tickets, he designed the ticket cancelling box now so familiar to the public, which so mutilates the ticket as to make it impossible to defraud the company by using it again.

Mr. Sergeant's inventive faculty and his suggestive and stimulating ideas were devoted to the interests of the Ingersoll-Sergeant Company for all the remaining years of his active life, and the business grew and prospered continually. The works at Easton, Pa., were occupied in 1873; the great shops at Phillipsburg proved a necessity a decade later; the consolidation of the two foremost but competing companies in their line in the world into the Ingersoll-Rand Company was the latest and final success. He spend much of his time in Easton until two years ago when failing health compelled him to give up his former activities. After the consolidation of the Ingersoll-Sergeant and Rand Companies he still retained his interest, although his health would not permit his active participation.

In his early days Mr. Sergeant was never content to tarry long under fixed conditions or in the same location, and up to 1893 he had made his home in twenty-six different cities and towns. In that year he located at Westfield, N. J., and at once took a deep interest in the growth of what was then but a small settlement. He built and owned at the time of his death the present home of the Westfield Club, the leading social organization in that section. He suffered greatly from rheumatism in his latter years, but the immediate cause of his death was paralysis.

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PERSONAL.

Thomas Farmer, of Detroit, Mich., has accepted a position with the Warner & Swasey Co., Cleveland, Ohio, as their Western representative.

J. C. Linder, for many years connected with the Abrasive Material Co. of Philadelphia, Pa., has been appointed superintendent of the vitrified wheel department of the Star Corundum Wheel Co., Detroit, Mich.

H. F. J. Porter has opened an office at 1 Madison Avenue, New York, and will engage in consulting industrial engineering work, making a specialty of organizing manufacturing companies on the basis of "industrial betterment."

William Coghlin, for nine years past prominently identified with The National Supply Company of Toledo, Ohio, has severed his connection with that company and entered the employ of The Patterson Tool and Supply Company of Dayton, Ohio. He expects to travel for the company in Ohio.

M. Woolsey Campau has accepted the position with the C. C. Wormer Co., Detroit, Mich., to represent that company on the road, principally in Michigan as salesman for steam plant machinery and machine tools. Mr. Campau is a graduate of the University of Michigan, 1897, engineering course.

Robert S. Riley, of New York, has taken over the control of the American Ship Windlass Company, Providence, R. I. Under the new management the company is making improvements in manufacturing facilities and preparing for an expansion of business. Mr. Riley was formerly with the New York Shipbuilding Company, and is also a director and consulting engineer for the Enterprise Transportation Company.

Fred. J. Miller, editor-in-chief of the *American Machinist*, resigned his position January 26. Mr. Miller was with the paper nearly twenty years—eight years as associate editor and twelve years as editor. At the present time poor health has prevented any definite plans for the future; it is not probable, however, that he will entirely give up the writing on mechanical subjects and kindred topics that has been his chief occupation for so many years, and which has made him so well known throughout the engineering world.

RECENT MILL HEATING INSTALLATION.

The new mill of the Blackstone Manufacturing Company, of North Smithfield, R. I., contains 40,000 spindles, and is a structure of three stories and basement, 366 feet long by 130 feet wide. On the east end is a picker house, 100 x 67 feet in plan, two stories and basement high, the latter being used as a dust room. At the west end is a weave shed 89 x 130 feet in plan, composed of one story and a full story basement. Both wings are built to carry additional stories in the future to the full height of the mill if desired, and the total frontage of the mill as now existing is 522 feet with a depth of 130 feet for most of this distance. The mill building is heated on the indirect system, consisting of steel plate fans and heaters installed by the B. F. Sturtevant Co., Boston, Mass. The heating coils and fans are located near the center of the west basement wall and the warm air is delivered to a number of vertical brick distributing flues by a horizontal concrete duct running beneath the basement floor along the entire course of this wall. The heating coils are located practically at the center of the duct which has a cross-sectional area of 8,640 square inches opposite the coils. The coils consist of a bank of about 12,000 feet of 1-inch pipe and the air is forced through the system by two 10½-foot fans, each direct-connected to a 10 x 12-inch engine. The typical vertical distributing flue starts from the basement with a 40 x 26-inch section, decreasing to a 20 x 26-inch section on the third floor. The openings from these for the supply of each floor are 20 inches square in sectional area, with the exception of the third-story opening, which has 20 x 24-inch dampers. The bottoms of the damper openings are located 10 feet above the floor level. Thence the air is forced across the entire width of the building, a distanc of 130 feet, and is thoroughly distributed. Perfectly equable temperature is thereby maintained. The slight excess of air pressure within the building tends to outward leakage.

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The spring convention of the National Machine Tool Builders' Association will be held at Fortress Monroe, May 7 and 8, with the Hotel Chamberlin as headquarters. It is expected that there will be a large attendance on account of the popularity of the place and the fact that the time is shortly after the opening of the Jamestown Exhibition. Further information may be obtained from the secretary, Mr. P. E. Montanus, of the Springfield Machine Tool Co., Springfield, Ohio.

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FRESH FROM THE PRESS.

We neglected to state in the review of the work "Electrical Engineering," by E. Rosenberg, reviewed in the February issue of Machinery, that the publishers are John Wiley & Sons, New York.

E. J. Frost, Jackson, Mich., has reduced the price of his book, "Essential Data on Bevel Gearing," to $3.00. This work, which was reviewed in Machinery, November, 1905, gives the face angle, cutting angle, outside diameter, pitch, cone radius, and number of Brown & Sharpe standard cutter for bevel pinions of 9 to 70 teeth inclusive, mating with tooth numbers 9 to 132 inclusive, all of 1 pitch; the lineal dimensions of other pitches are readily deduced by simply multiplying or dividing by the given factor. It contains in all about 70,000 items of computed data, the object of which is to do away with mathematical drudgery in the drafting room and shop.

Modern American Machine Tools. By Prof. C. H. Benjamin. 320 pages 5½ x 9, 134 illustrations. Published by E. P. Dutton & Co., New York.

This work on American machine tools, reviewing their general characteristics, is the same as that noted in the January, 1907, issue which was brought out by Archibald Constable & Co., London. The American rights have been acquired by the above concern.

Artillery and Explosives. By Andrew Noble. 548 pages, 6 x 9½ inches. Published by E. P. Dutton & Co., New York. Price $6.00.

This book contains a number of essays and lectures written and delivered at various times. While for this reason not a complete and logically arranged work, it contains a mass of valuable information to persons engaged in the design and testing of large guns, and particularly to those interested in the qualities of explosives. A great deal of attention is given to researches and experiments on explosives, and to the peculiarities of their action in rifled artillery.

The Schulz Steam Turbine for Land and Marine Purposes. By Max Dietrich. 73 pages, 6 x 9¼ inches. 43 cuts. Published by E. P. Dutton & Co., New York.

This is the first volume of a series of treatises entitled Modern Steam Turbines, edited by Arthur R. Liddell. It is merely a review and description of the Schulz patents and a summary of the experiments and tests undertaken with the Schulz steam turbine. The volume may be of value to those who wish to closely follow up what improvements are made in steam turbine design.

The Elastic Arch. By Burton R. Leffler. 59 pages, 5 x 7½ inches. 3 folding plates. Published by Henry Holt & Co., New York. Price. $1.00.

This work is a treatment of the theory of the elastic arch, with special reference to the reinforced concrete arch. It gives a method of designing a reinforced concrete section for combined thrust and moment; it also includes a graphical analysis of an arch of oblique forces. The arch is analysed and theoretic deductions given. The work is timely in its treatment of reinforced concrete and its vagaries.

CONTENTS FOR MARCH.

The Principles of Mechanism. By Herbert A. Garratt. 166 pages. 5 x 7¼ inches. 162 cuts. Published by Edward Arnold, London, and Longmans, Green & Co., New York.

This small volume, which purports to be a short treatise on kinematics and dynamics of machines, deals with its subject in a purely theoretical manner. It will undoubtedly be serviceable to everybody who wants to study the principles of kinematics without spending too much time and energy on a voluminous presentation of the matter. The various subjects dealt with are treated in as simple and comprehensive a manner as is consistent with the object of the book.

Modern Plumbing Illustrated. By R. M. Starbuck. 392 pages, 7½ x 10½ inches. 55 plates containing numerous cuts. Published by Norman W. Henley & Son, New York. Price $4.00.

This work is a comprehensive and practical treatise on approved methods of plumbing construction. It is thoroughly practical; it will undoubtedly be valuable to the plumber in his actual work, and to anybody who is called upon to decide questions regarding plumbing. Specific details are given, greatly enhancing the value of the book. Representing, as it does, the latest and best modern practice, it will also be a book of value and interest not less to the architect and builder than to the practical plumber.

The Slide Rule: A Practical Manual. By Chas. N. Pickworth. 104 pages, 5 x 7 inches. 24 illustrations. Published by D. Van Nostrand Co., 23 Murray St. and 27 Warren St., New York. Price, $1.00 net.

This little book has now reached a tenth edition, a fact which gives reasonably sure evidence of the usefulness of the work. Considerable additional matter has been incorporated, especially that relating to new forms of "log.-log." slide rules, and other special instruments of recent introduction. The book takes up, in turn, the mechanical and mathematical principles of the slide rule, the explanation of the simpler uses of the ordinary forms proceeding from that to compound multiplication and division, involution and evolution, trigonometrical applications, etc. A valuable table of conversion factors is given, as well as settings for constants used in various branches of engineering. A large number of practical examples are worked out.

Text-Book on Hydraulics. By L. M. Hoskins. 271 pages, 6 x 9 inches, 125 cuts and diagrams. Published by Henry Holt & Co., New York. Price, $2.50.

The work is one designed for the use of students of engineering schools and aims to give a thorough grounding in the principles and theory of hydraulic phenomena. It treats of the principles of hydrostatics and then takes up the flow of water through orifices; the theory of energy applied to steady stream motion; flow in pipes; frictional loss of head in pipes; flow in open channels; measurement of rate of discharge; dynamic action of streams; types of turbines and water wheels, theory of the impulse turbine; theory of the reaction turbine; principle of the tangential waterwheel, turbine pumps, etc. The work is well printed and the mathematical work is attractively presented. A good feature of the work is that each chapter contains a number of problems with answers which are designed for the student's self test.

Steam Turbines. By Lester G. French. 418 pages 6 x 9 inches, 250 cuts. Published by the Technical Press, Brattleboro, Vermont. Price $3.00.

This work had its inception in the editorial offices of Machinery, when the author was its editor, and a number of the chapters, in whole or in part, were published in its columns during 1904, 1905 and 1906. Hence the general character of the work is already known to many of our readers. The work explains the principles of the steam turbine, gives a brief resume of the history of the art, and then follows with detailed information about the various types of steam turbines that have been built. These chapters include simple impulse turbines, the Pelton and similar types, compound impulse turbines, reaction turbines, and miscellaneous types. A valuable chapter on steam turbine performance follows, containing tables of results of turbine tests and of tests upon reciprocating engines, for convenience in comparison. The continuation of this chapter takes up the characteristics of turbines for variable loads, the effect of vacuum on economy, effect of superheating, etc. Chapter XI is devoted to experiments on the flow of steam and represents a great deal of labor and research on the part of the author and others. The appendix includes four diagrams showing the kinetic energy of steam in foot-pounds and the velocity of a steam jet in feet per second. The mathematical treatment has been limited mainly to a discussion of the adiabatic flow of steam and to the principles of turbine vanes, etc., and has been made as simple as the nature of the subject will permit. In this connection it might be noted that Mr. French's editorial work on Machinery for the past nine years well fitted him for the preparation of such work, which is designed to appeal to all classes of men interested in prime movers, whether firemen, engineers, inventors or designers. It is presented in simple language and the underlying principles and application are intelligently discussed in a manner that makes a study of the work a pleasure. The typographical appearance of the work is exceptionally fine. It is well printed and well bound. The engravings, both line and half-tone, are exceptionally good, and altogether the work is one that can be referred to as a standard of what a technical work should be.

Engineering Materials. By Edward C. R. Marks. 98 pages, 4¾ x 7½ inches. 38 cuts. Published by the Technical Publishing Co., Ltd., Deansgate, Manchester, and Strand, London. Price, 60 cents.

The book in review is of the second edition and has been entirely rewritten and added to, making largely a new work. It is the aim of the work not to present an exhaustive treatise of metallurgy, but to give concisely practical information on the characteristics of the principal engineering metal materials, therefore treating of cast iron, wrought iron, steel, copper, brass, malleable iron, babbitt or bearing metals, etc. The aim of such a work as this is to be commended. There are many who desire elementary books on almost any given subject which will give a general grasp of the subject as a whole without going into minute details. In fact it is in general necessary for any one in approaching a subject to be able to comprehend the principal facts of the subject before they are in proper condition to study its details. The work in review is one which might be unfavorably criticized in some respects, and commended in others. In places it seems to lack authority of expression, but substitutes quotations from papers by eminent metallurgists. In a book of this character we believe there should in general be the assumption of authority on the part of the author to make certain definite statements. It will satisfy most readers of the elementary class far better. Some parts are well done; the chapter on steel explains the difference between the acid and basic process steels which are made by both the open hearth and Bessemer methods. It is pointed out that high-grade crucible steels are by necessity high-priced, inasmuch as they must be made from iron free from sulphur. This in England largely means Dennemora or Swedish iron. These irons cost from 5 to 6 cents per pound to begin with, hence the impossibility of producing first-class crucible steel at the prices often quoted. The cheap processes for manufacturing crucible steel have one and all failed, and to-day the old-time method pursued by the Sheffield steel makers is still the one that produces the reliable tool steels.

NEW TRADE LITERATURE.

Kerr Turbine Company, Wellsville, N. Y. Bulletin No. 2 describing the Kerr steam turbine and steam turbine blower sets.

New Haven Manufacturing Co., New Haven, Conn. Crystaloid sign advertising 36-inch swing engine lathe.

Goldschmidt-Thermit Co., 43 Exchange Place, New York City. Pamphlet on Thermit Rail Joint describing welding outfit, material and working plan.

B. F. Barnes Co., Rockford, Ill. Illustrated catalogue of "Twentieth Century" machine tools describing upright drills, lathes, tool grinders, key seaters, etc.

American Blower Co., Detroit, Mich. Catalogue No. 206 on vertical self-oiling engines, stating points of superiority, adaptability, economy, describing lubricating system and giving tables of specifications.

Garvin Machine Co., Spring and Varick Sts., New York City. Circulars Nos. 53 and 54 illustrating and describing vertical spindle milling machines and motor driven milling machines respectively.

Gisholt Machine Co., 1316 Washington Ave., Madison, Wis. Leaflet describing a pulley job which shows how this class of work can be finished to good advantage on the American turret lathe.

Niles-Bement-Pond Co., Trinity Building, 111 Broadway, New York City, have issued *Progress Reporter* for March, 1907, which treats of Pratt & Whitney 16-inch toolmakers' lathe, pneumatic clutches for planer drives, 600-ton hydraulic wheel press, etc.

The R. A. Kelly Co., Xenia, Ohio. New catalogue describing their entire line of crank shapers. All of these shapers may be readily equipped for electrical driving. Prices for extra attachments will be furnished upon request.

Baker Brothers, Toledo, O. Catalogue No. 5B describing drilling, boring and tapping machinery, among which are included manufacturing drills for general machine shop use, semi-automatic tapping machine, car wheel boring machines and locomotive rod boring machines.

Cleveland Twist Drill Co., Cleveland, O. Catalogue 32 illustrating and giving specifications for their line of drills, reamers, sockets, bits, taps, etc. A number of new tools are included. Catalogue 34 devoted to high-speed drills, containing hints on the use of high-speed drills as well as specifications for the various types.

The International Committee of Young Men's Christian Associations, 3 West Twenty-ninth St., New York, have issued *Progress and Outlook*, for 1906, summarizing the year's work. Special attention is called to the page containing the summary of a year's growth and to the page concerning the association's railroad buildings.

The Ingersoll-Rand Co., 11 Broadway, New York. Catalogue H-36. Describing a single line of air compressors known as type H. These air compressors are duplex, steam-driven, automatic machines mounted on a single base and entirely self-contained, and are made in sizes ranging from below 10 to over 200 horse-power.

The B. P. Fortin Tool Co., Woonsocket, R. I. Catalogue describing and giving specifications of the B. P. Fortin universal jigs. It is the